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DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

EDITED BY A. S. RUSSELL, M.C., D.Sc.

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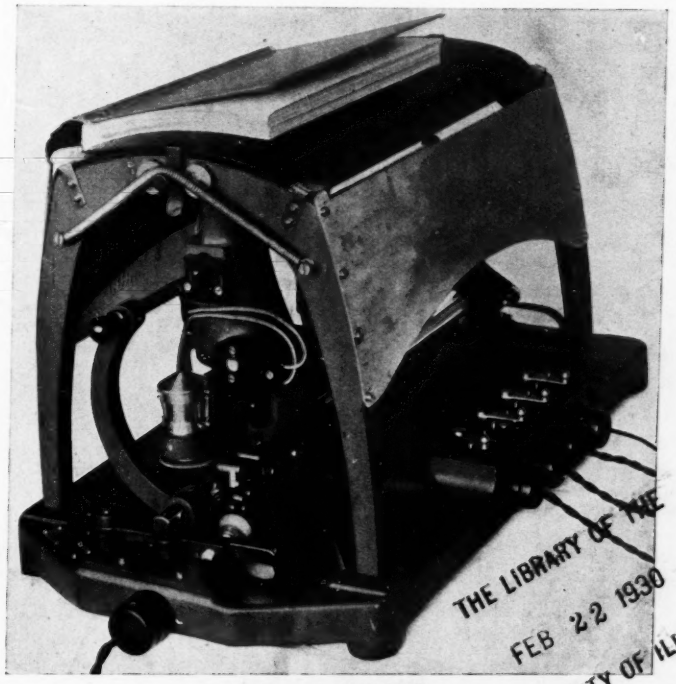

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JOHN MURRAY, 50A ALBEMARLE STREET, LONDON, W.1.

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Editorial Notes

IT is a great thing when a man, who knows his subject and wants others to share his knowledge, can so express himself that we, the general public, may not only follow him intelligently, but become interested in his subject, fascinated perhaps. The expert is sometimes prevented from writing on his subject so that his readers get the maximum pleasure possible in reading him, not because he is incapable of writing informingly and interestingly, but because unfortunately he is afraid of a bogey-man. The bogey-man sits up at the back behind the ninety-and-nine who want the matter explained simply, and spoils everything. The lecturer or the writer cannot let himself go. He dare not be funny. He must not express his personality. For there before him is the bogey-man detecting every error, charging him ironically with bringing down matters to his level, muttering "superficial" or "writing down" or "childish analogies," and so it is that sometimes writers who were once good men become stiff and starchy, difficult and dry-as-dust.

* * * * *

Professor Weekley, of Nottingham, is not one of these. He is one of those who believes that, inasmuch as books are written to be read, a good book should be, above all, interesting. His books on *Surnames* and *The Romance of Words* have done much to popularise the highly interesting subject of the origin and meaning of words, but this new book of his, the dictionary,[1] is his best book. It is a triumph. He has given us a jolly book without being superficial or inaccurate. He offers it to those lovers of our language who, "without wishing to stumble about in the dim regions which produce prehistoric roots and conjectural primitive-Teutonic word-forms, have an educated interest in words and an intelligent curiosity as to their origins and earlier senses."

* * * * *

This dictionary does not, of course, fulfil the function of an ordinary dictionary. It does not give pronunciation of the words, and the only definitions given are brief indications necessary to suggest the region of ideas to which an unfamiliar word belongs; there is all the more room, therefore, for an exposition of how, why, and when words and phrases came into our language. The vocabulary is that of *The Concise Oxford Dictionary* or Cassell's *New English Dictionary*, but a great number of scientific and technical words which, for Professor Weekley's purpose, can hardly be regarded as forming part of the English language, have been omitted. Slang words and expressions, hitherto passed over by etymologists, are here historically explained, and foreign words are included if they are likely to occur in reading and in "educated conversation." He has attempted, indeed, to include the whole of the literary and colloquial vocabulary so far as the former is not purely archaic, and the latter not purely technical or local. Quotations form an important feature of the dictionary. Professor Weekley feels that a dictionary "without quotations is too unrelieved in its austerity. Those included here range chronologically from the Venerable Bede to Mr. Horatio Bottomley. . . . Some are given to prove the occurrence of a word, others to illustrate an interesting phase of meaning or an obsolete pronunciation, . . .

[1] *An Etymological Dictionary of Modern English.* By Ernest Weekley, M.A. (John Murray. 42*s.* net.)

and a few no doubt, because their quaintness, appealed to the compiler."

* * * * *

A review of this book by one who is not a professional philologist, may decently be confined to a few quotations therefrom. Portmanteau words form an interesting class. Many of these are much older than the name itself, which was invented by Lewis Carroll, in 1871, to explain *slithy*, *mimsy*, and other words occurring in *Through the Looking-glass*. ("You see, it's like a portmanteau—there are two meanings packed up into one word.") *Peterloo* (St. Peter's Fields × Waterloo), for example, was invented in 1817. A good portmanteau word should indicate both its meanings clearly, and should not offend a purist too much. *Hunshevik* is not a good example, nor is *petrollick*. *Bakerloo* and *Eurasian* are better.

* * * * *

Proper names that have given rise to words like *bunkum*, *bowdlerise*, *boycott*, and *Mrs. Grundy*, form a second interesting class. Mrs. Grundy was a character in Morton's play, *Speed the Plough*, produced in 1798. Several times in it there is spoken the now familiar phrase: "What will Mrs. Grundy say?" The definitions of *bowdlerise* and of *boycott* are well known. Bunkum comes from a county called Buncombe in North Carolina, the member for which once insisted, towards the end of a wearisome debate in Congress, on "making a speech for Buncombe," i.e. showing his constituents that he was doing something for them. Judge Halliburton's opinion may be quoted in substantiation:

"All over America, every place likes to hear of its member of Congress and see their speeches; and if they don't, they send a piece to the paper, inquirin' if their member's died a natural death, or was skivered with a bowie knife, for they hante seen his speeches lately, and his friends are anxious to know his fate. Our free and enlightened citizens don't approbate silent members. . . . So every feller, in bounden duty, talks, and talks big too, and the smaller the state, the louder, bigger and fiercer its members talk. Well, when a crittur talks for talk sake, jist to have a speech in the paper to send to home, and not for any other airthly puppus but for electioneering, our folks call it 'Bunkum.'"

* * * * *

The dictionary shows that many well-known phrases are older than one might suppose. "Queen Anne is dead" cannot occur before Queen Anne's time, yet in her time there was an earlier version:

"What news, Mr. Neverout?"

"Why, madam, Queen Elizabeth's dead."—SWIFT, *Polite Conversation*.

Hobson's Choice may be earlier than the time of Hobson, the Cambridge livery-stable keeper, who refused to let out his horses except in strict rotation, to whom the phrase is usually ascribed. It occurred modified as *Hodgson's Choice* in a letter written as early as 1617.

A *fountain-pen* was described in France in 1658, and Fanny Burney used one in 1789. The slang word *wangle* dates from 1888. On the other hand, some phrases are startlingly modern, *journalism* (1833), *Tommy Atkins* (1883) (*Thomas Atkins*, a specimen name used in filling up Army forms, dates from 1815), *Tommy* (for the soldier) (1893), *week-end* became general about 1885, and the *nonconformist conscience* in 1890 at the time of Mr. Parnell's fall. *Motor-car* was used in 1895 (it was in November 1896 that a motor-car was first allowed without a red flag), and joy-ride in 1909.

* * * * *

It is good to meet again words like *villain* and *prevent*, whose original meanings have been altered in time. There are others whose meaning has been distorted, owing to a misunderstanding of the source from which they came. The journalistic phrase "the psychological moment," meaning approximately "just the right moment," is due to a misunderstanding of the German *psychologisches moment*, the psychological *factor*. This phrase was used by a German newspaper in 1870 in reference to the anticipated effect of the bombardment of Paris on the *moral* of the besieged. It has now passed, as the New English Dictionary put it, "nonsensically into English journalese."

It is curious that the phrase *the Pilgrim Fathers* apparently dates only from 1799. The Puritans who landed in 1612 at Plymouth Rock in Massachusetts were called pilgrims, not pilgrim fathers. It is a pity if this be true. Perhaps America can supply a quotation of the phrase which will save the situation.

* * * * *

Professor Weekley has continued the Johnsonian tradition in allowing humour and cheerfulness occasionally to break through. Thus he describes *unquestionably* as a word which is used "in philology usually in reference to some hazy recollection of an amateur theory propounded in the correspondence column," and adds this quotation:

"Dreyfus has nothing to do with 'tripod.' It comes unquestionably from the city of Trêves."—*Observer*, December 31, 1916.

Of *astrolabe*, after giving its derivation, he says, "Used in desperation by Swinburne," and gives the verse from *Poems and Ballads*. *Values* enables him to give Mr. H. G. Wells a little dig. Following its definition, are these two quotations:

"We apologise to Mr. Wells for using the word 'values,' since he dislikes it.—*Times Lit. Supp.*, June 5, 1919.

"The hooligan sees none of the values of the stranger. —H. G. WELLS, *The Observer*, January 18, 1920.

Under *mixed metaphor* he quotes the following from that well-known monthly magazine, *The Fortnightly Review*:

"In 1914 our old regular army crossed swords with a great numerical superiority of the cream of the German host at concert pitch and undamaged by war."

It would be hard to beat this metaphor without mixing one up deliberately.

The word *serviette*, he says, is common in Scotland from the fifteenth century, but in England it is a late nineteenth-century refinement, now considered vulgar. He might have added, with propriety, the well-known quotation from *Punch*:

"No one mentioned in *Debrett*,
Talks about a serviette."

Yet if you are Scot, you may.

Under *Spoonerism* Professor Weekley gives the excellent "kinkering congs." A later one which may be new to some is the exclamation of an old man demanding assistance on a windy day: "Will no one pat my hiccough?"

* * * * *

It remains to say a few words about slang. In this the dictionary is very properly well up-to-date, for slang has enjoyed greater licence and prestige of late years than at any previous time. "The slang of one generation," Professor Weekley remarks, "has often become the literary language of the next, and the manners which distinguish contemporary life suggest that this will be still more frequently the case in the future." Sport, the sea, Anglo-Indians, American story-writers, the cinema, the Stock Exchange, and the War have been fruitful sources of slang. *Cushy*, *blighty*, *pukka*, come from Indian languages. *To get it in the neck* appears to allude to "where the chicken got the axe." A playful variation is, "where Maggie wore the beads." This trick of dressing up old proverbs and phrases in modern clothes is chiefly American, and was used by O. Henry with great success. It can be very entertaining. Many of the War words will disappear from the language because the conditions that gave rise to them have gone. Others, like *stunt* and *gawblimey*, have been used so often that people are sick of them. A good deal of slang is self-explanatory—*cold feet*, for example; many phrases, such as *the Pragger Wagger* for the Prince of Wales, have simple explanations, if certain facts are known; but for many expressions no explanation has been suggested. Why is sixpence a *tanner*? and whence arose the phrase *the answer is a lemon*?

* * * * *

This book should settle most of the arguments about words that one hears in railway-carriages or smoking-rooms, or reads of in the correspondence columns of newspapers and popular weeklies. Before consulting the dictionary, it might be well to write on a sheet of paper the phrases you wish to turn up. Otherwise, unless you are some kind of a Pelmanist, your attention will be led sadly astray by other words.

* * * * *

Books on the Theory of Relativity still appear. Recently the whole of one issue of our contemporary *Nature* was devoted to an exposition of the theory, from fourteen points of view. Each contributor was assigned a task, and has endeavoured to say his say in as accurate and understandable a way as possible. Among recent books that have appeared are *The Theory of Relativity*, by Prof. R. D. Carmichael, of the University of Illinois (Chapman & Hall, 8*s*. 6*d*.), and the second edition of *Relativity, The Electron Theory and Gravitation*, by Mr. E. Cunningham, of St. John's, Cambridge (Longmans, 10*s*. 6*d*.). These books are for students. The most popular exposition is still Dr. Lawson's translation of Einstein's *The Theory of Relativity* (Methuen, 5*s*.), now in its third edition.

* * * * *

Following Mr. Wordie's article of last month on polar exploration are two in this number, one on the Arctic by Dr. Rudmose Brown, the other on the Antarctic by Mr. Debenham. These three writers are well-known polar authorities. Dr. Rudmose Brown's article, dealing as it does with the Arctic, necessarily covers some of the ground described by Mr. Wordie; but there is much that is new and different, and a comparison of the views of men who have made not one only but several voyages to high latitudes is of interest.

* * * * *

Several new journals dealing with the advancement of learning in their subjects have recently commenced or resumed life. *Photographic Abstracts* is a new quarterly published by the Royal Photographic Society of Great Britain. Its aim is to give to both the practical and scientific photographer a concise epitome of published work both at home and abroad. *The Antiquarian Journal*, two quarterly numbers of which have appeared, is the journal of the Society of Antiquaries of London. It should enlist the interest and support of the general public in touch with antiquarian matters. The Liverpool *Annals of Archæology and Anthropology* has resumed publication, a journal which had a distinguished career before the war.

* * * * *

There are two books recently published which we wish to recommend whole-heartedly to readers. The first of these is *A Survey of English Literature*, 1830–1880, by Prof. Oliver Elton, of Liverpool,[1] and the second

[1] Arnold. Two volumes, 32*s*

Queen Victoria, by Mr. Lytton Strachey,[1] the author of *Eminent Victorians*. We hope all libraries will get possession of copies of these books and that our readers will lose no time in reading them. An account of Queen Victoria will apear in these pages next month.

Antarctic Exploration in the Future

By F. Debenham, B.A.

Fellow of Gonville and Caius College, Cambridge

THE question is often raised, even in geographical circles, as to whether there is any field for further exploration in the polar regions now that both the Poles have been reached by man. Such a question discloses the extent to which the world has been led to believe that the poles themselves were important, and shows also how little is known of the less spectacular sides of polar work. It is answered very effectively by the fact that immediately after the discovery of the South Pole a large British expedition set out for the Antarctic, and that at present the first man to reach that point, Captain Amundsen, is occupied in an attempted drift across the North Polar Ocean. In both cases we may allow something for the fascination of the work itself, but we must also account for the support that is given by men who cannot go themselves.

The episode of the siege of the poles has now passed, leaving a wonderful tradition and stories of human bravery and endurance that are in themselves an asset to mankind. But now that it has passed, we can perhaps obtain a better view of polar work, and bring it into a more natural perspective. If we ignore for the moment the narratives of that siege, we shall find that the history of polar exploration is really the history of adventurous trade, one expedition after another setting out to find either new trade routes or natural resources, or even to develop polar industries themselves. And we may say at once that their aim has been achieved, that the world as we know it has profited well by its polar resources. A very brief inquiry into the profits of the Greenland whaling, or the Arctic fur and seal industry, or even the mineral deposits of Greenland and Spitzbergen, will show that they are far greater than the expense of finding those resources. In the lesser known Antarctic seas we already have a young and vigorous whaling industry which has produced a value of over twenty million sterling in the last decade.

Early in the nineteenth century a new type of story comes on the page of polar history, and together with the adventurous trader we find the adventurous scientist. One of the earliest expeditions of that type was the British one under Sir James Clark Ross, and its chief aim was the careful observation of magnetic data in the vicinity of the South Magnetic Pole, which was duly carried out. A rich harvest of geographical discovery was reaped at the same time. Since then we have had, and will continue to have, both types of expedition, or both aims in one expedition.

But whether it is the adventurous scientist or the adventurous trader that carries out polar work, we must emphasise the adjective rather than the noun, in other words, the impulse underlying either is adventure. Exploration in general and polar exploration in particular is an instinct, developed more strongly in some nations than in others perhaps, and it is to that instinct that we really owe the whole of our geographical knowledge. Reading our polar history from that inside point of view, we shall find it certainly instructive and often amusing to note how, in the preamble of objects before any expedition, the veneer of scientific or industrial reasons so barely covers the real impulse, the search for the unknown and the yearning for adventure.

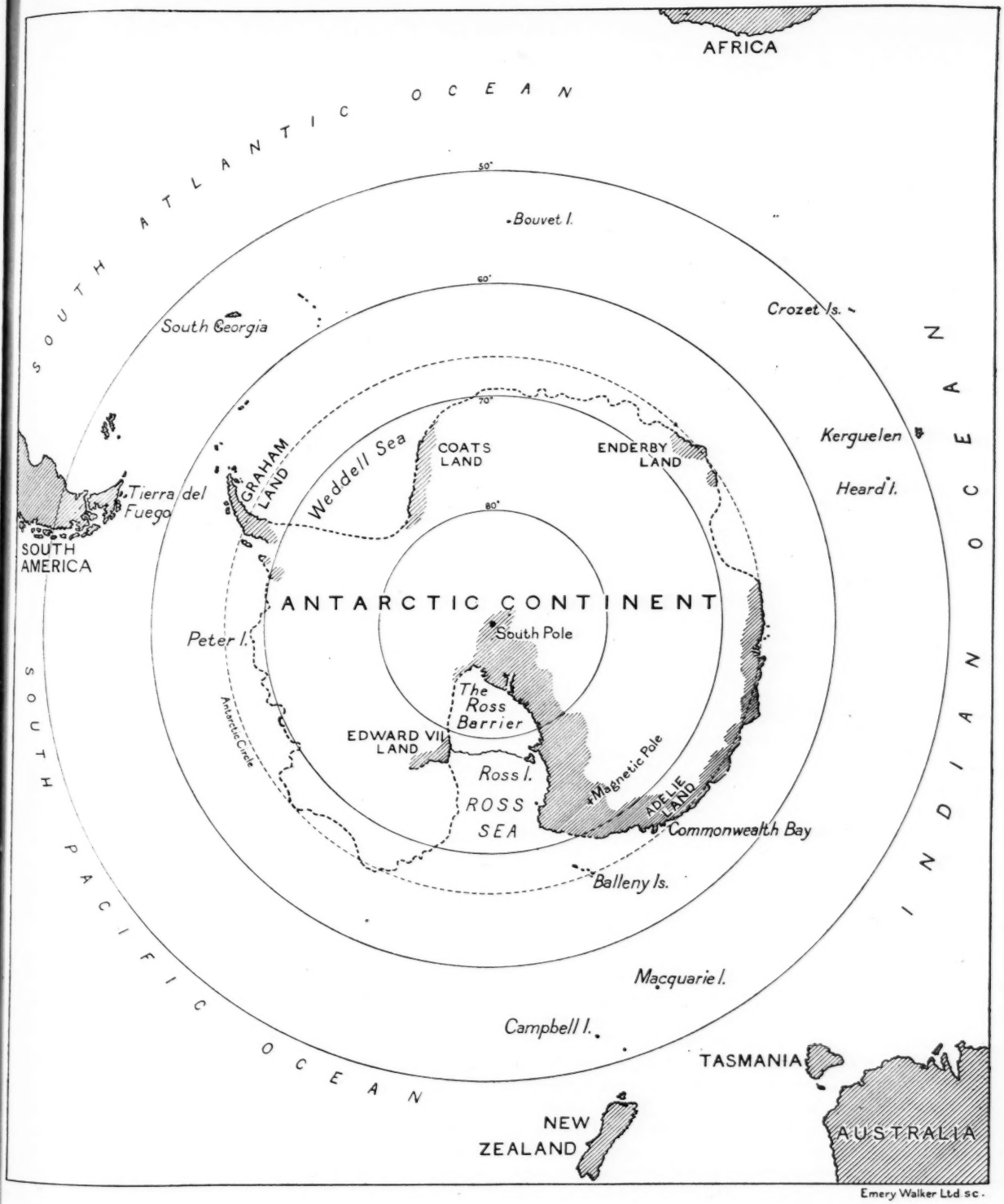
The existence of this instinct is alone sufficient to vouch for a continuous future for polar work, for men will invent reasons for it or carry it out with no reason at all. It becomes then our business to see what good reasons there may be, to direct this impulse, as it were, into useful channels.

We can classify the aims of polar knowledge into three parts. There is the aim of the true geographer who yearns to fill in the blank spaces on his map, to know with reasonable certainty the outline and relief of every part of the globe. There is the aim of the merchant, the trader, and the miner to discover and develop all the natural resources of the world, whatever their latitude. There is the aim—a modern one—of the world scientist to complete his geo-physical data in high latitudes as well as in temperate and tropical regions. His immediate purpose may be the actual shape of the earth—geodesy—it may be the relation between the land masses—geology—or it may be any one of a number of sciences which depend on a complete knowledge of the earth's surface—meteorology, oceanography, earth magnetism, and others. If the first appeals to our sentiment, the second appeals to our pocket and the third to our brain and indirectly also to our pocket, for it must be remembered that what is the pure science of one generation is often the applied and industrial science of the next.

The first aim, then, is that of pure discovery, and we may turn to our maps to see what remains unknown.

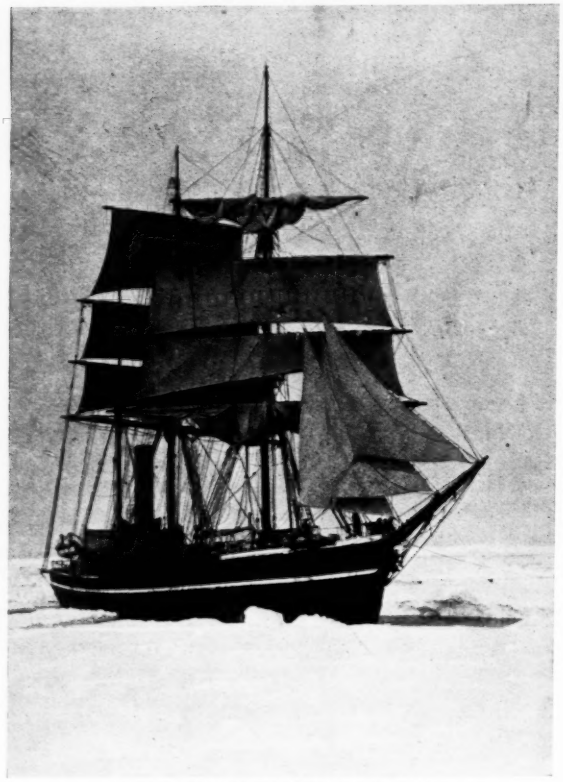
In the South Polar regions, as a glance at the map will

[1] Chatto & Windus, 15*s*.



Emery Walker Ltd sc.

show, the extent of the unknown is far larger than in the north, and, in point of expense, more difficult of attack. We can be fairly certain that the area within the Antarctic Circle is mostly continent, and we infer also that it is for the most part very high land and ice-covered. But except in one sector, that to the south of New Zealand, we can hardly vouch for anything on land, for it has only been from observations taken from shipboard that we know of land beyond the circle. Two avenues of approach have been opened up in the past, and no new ones have been found or used. Ross



SHIP HELD UP BY THICK PACK-ICE.
There is a fringe of floating pack-ice around the whole continent, which can only be passed in wooden ships.

in 1841 found that with a stout ship one could force the floating pack-ice which fringes the continent and penetrate far south in a comparatively open sea, since named the Ross Sea. That avenue has been used to reach the pole, as we know, but it has also given access to the continent for several expeditions whose object was mainly scientific, so that it remains the best-known part of the continent.

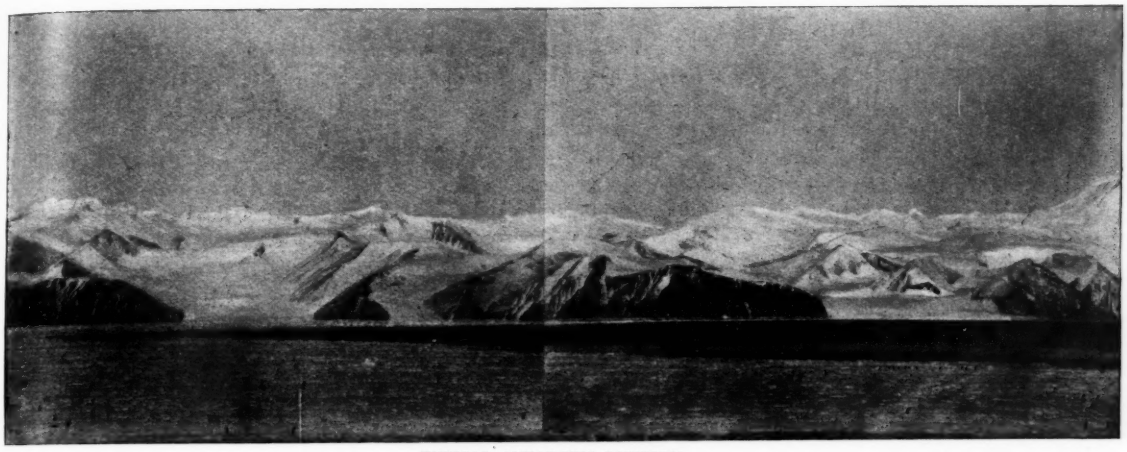
Another avenue exists to the South of Cape Horn in the form of a long tongue of land and scattered islands, apparently an extension of the main continent, reaching as far north as 63° S. lat. The credit of its discovery must be divided among many, but we may chiefly connect with it the name of Bellingshausen, the commander of a Russian expedition which sailed round the Antarctic continent in the early twenties of last century, a worthy successor to Captain Cook, who did the same fifty years before. Being a land avenue of a rather forbidding character, it has been hardly used for penetrating southwards, but nevertheless offers a path which will not be ignored in the future. To the east of the land tongue of Graham Land, as it is generally called, is the Weddell Sea, and this is regarded to some extent as an avenue comparable to the Ross Sea. More exact knowledge may confirm the sea in this character, but so far its reputation has been far from good. The sealer-explorer, Weddell, penetrated to 74° S. in 1823, it is true, and that without encountering any pack-ice; but those who have followed in his track have fared badly. The *Scotia* in 1904 equalled his record, but had to battle through much ice. The *Deutschland* in 1910 beat him by four degrees, but was beset by ice for many months and barely escaped. Lastly the *Endurance*, in 1915, had the same experience, but was finally crushed and its crew marooned on the ice.

There is therefore ample scope for purely geographical work in the South, and we may indicate some of the probable points of future attack.

As far as the coast-line of the continent is concerned, the greatest gaps are to the south of the Pacific Ocean, and to the south of the Atlantic—between Coats Land and Enderby Land. One would expect that these coasts would be finally plotted from circumnavigating ships, but in the case of the first there seems little possibility of doing it that way. Attempts have been made, both from the Ross Sea end and from Graham Land, to trace the coast in between. Scott in the *Discovery* did get far enough to determine the trend of the coast, and to see that only very powerful ships well supplied with fuel would be able to get far along the coast in that direction. The *Belgica*, under Gerlache, attempted the same thing from the other end, and was caught in the ice and drifted about for a year before getting free again.

The most promising method of attacking this strip appears to be by land parties using the sea-ice and fringing ice shelf for their route, and choosing their base in King Edward VII Land or Charcot Land. A landing has not yet been made on either of these places, but would be possible in the former in most seasons.

It is somewhat surprising that there has never been a determined attempt to follow up the discovery of Enderby Land by Biscoe, another whaling-explorer, in 1831. With the steam whaler there should be little difficulty in reaching the land there—Biscoe did not

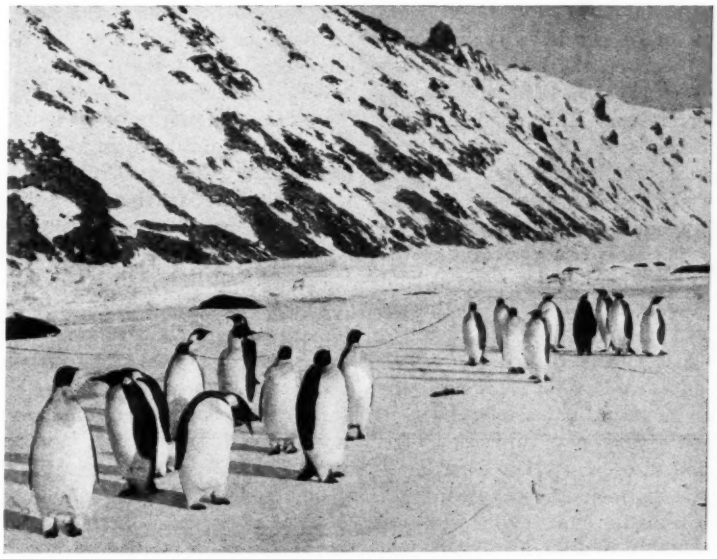


TYPICAL ANTARCTIC SCENERY.
Note the absence of bare rock except on slopes. Robertson Bay, South Victoria Land.

get closer than about five miles—and placing a land station from which land journeys might be undertaken. On the other hand, a ship in an open season might run in the coast much more cheaply and rapidly than any land party could hope to do.

There is another direction for land journeys which has not been followed since it was pioneered by Nordenskiold in 1902, and which offers a fair route for a long journey down the western side of the Weddell Sea. The coast is there flanked by a thick permanent sheet of ice which gives a good surface for travelling, and Nordenskiold had to turn back even before he had reached the Antarctic circle. An attempt to get well south along this route is being made this year by a small British party, who are being landed on the northern end of Graham Land by the Norwegian whalers who constantly hunt in these seas.

The most important geographical problem of the South is the nature of the connection, if any, between Graham Land and the rest of the Antarctic continent; but there are many others of minor interest, such as the limits of the high plateau, the direction of slope and consequent movement of the ice sheet over it, the existence and trend of mountain ranges. It is, for instance, not impossible, though highly improbable, that there may be ranges of mountains comparable



EMPEROR PENGUINS AND WEDDELL SEALS.
The only permanent inhabitants of the Antarctic foreshores. There are no land animals whatever.

in height to the Himalayas still to be discovered in the heart of the great continent.

So much for the geographical secrets of the Antarctic; we turn now to consider its possible commercial future. The one industry which it can boast at present is that of whaling, and already the greater part of the world's supply of whale oil comes from the Antarctic and sub-Antarctic seas. Those seas are not yet fully exploited, and the Ross Sea, for instance, is quite untouched, although it is famous for its large schools of whales. If the need for animal oil continues, as seems probable, other centres for whaling will be opened up, and as long as the hunting is carefully regulated by law, the supply should be kept up perennially. Incidentally, much more information about the life-history of whales is required before such regulations can be properly planned.

On the continent itself there are no industries nor even the beginnings of one. Where there are no land animals there can be no fur industry, which is the great stand-by in the North Polar regions. There remains the prospect of finding payable minerals, and a great deal has been claimed for the future of such a vast continent in this respect. From what we know of the structure of the continent, we can say with assurance that there must be gold and other precious metals there. But whether they will ever be discovered in payable amount is very doubtful indeed. So far nothing but indications of copper have been found, though geologists have been on the lookout for ores in the few parts of the coast which have been visited.

The reason why there is very little chance of the probable wealth of minerals in the Antarctic ever becoming of use to man is that it is for the most part buried by a thick ice sheet which prevents it from being found, as well as providing difficulties if it ever were found. For the Ross Sea quadrant of the continent the proportion of bare to ice-covered land is about the same as the area of London to that of all England. Also the bare land where it occurs is often in the form of inaccessible cliffs. The search for gold will continue as a side-line for the prospecting geologists, but only the most unusual coincidence will unveil a deposit which would pay to work. The existence of coal of moderate quality has been established in two or three places, including the Beardmore glacier, only 300 miles from the pole, but naturally it is not likely to be profitably worked for a very long time to come.

The economic resources of the land itself, therefore, appear to be negligible judged by our present standards, though there is always the possibility of lucky finds which may give rise to small industries similar to the cryolite mines of West Greenland, a key industry to the production of aluminium.

There remains to us the third aim of polar exploration, the more strictly scientific one of completing our knowledge of world phenomena by observations in the Antarctic. Unfortunately, this is an aim which cannot appeal very greatly to the lay mind, for the value of such observations is not direct and may be long delayed.

In some of the brine wells of Southern China a new bore may take as long as sixty years to put down by the slow and laborious methods in use by the inhabitants. Yet a Chinaman will cheerfully commence such a bore, knowing that only his grandson can reap the profit from the work of two generations. Something of this patience and foresight is required in the prosecution of Antarctic research.

We can but briefly outline the necessity for such work, the final results of which it is almost impossible to forecast.

It is obvious that the weather, and particularly the rainfall, is of vital importance to mankind. If in some distant age it becomes possible for the weather prophet to forecast with assurance the next season's weather, the value to the agriculture of the world will be immense. At first sight that appears an impossible dream, but so was the conquest of the air less than a century ago. But if it is to be done, it can only be through the careful study of all the factors that go to produce our weather, and amongst these are the atmospheric conditions at the polar regions. Every schoolboy knows the importance of the equatorial belt as influencing the seasons and the weather, but few know that the polar regions act as a complement to that belt, and have an almost equal value in determining the weather. Until there is a vast amount of meteorological data from the polar regions, the problem cannot be properly set before the people concerned with it, and obviously such data can only be obtained by going and living there for long periods.

There are other branches of science which depend for a great part of their data on conditions at the poles, branches which must remain incomplete until someone goes and takes them on the spot. Terrestrial magnetism, for instance, is a property that we use in all navigation, and the world spends vast sums every year in following the vagaries of the magnetic needle and keeping its charts up-to-date. The earth as a magnet can be best studied at the poles of the magnet, and both of those are in the polar regions.

It would be possible but tedious to follow out the influence of those regions in half a dozen of the better-known branches of science, all of which are useful in a more or less direct way to mankind in general.

We may sum up the future of Antarctic exploration somewhat as follows: The first duty is to discover the limits of the continent and its main features, which

demands several long sledge journeys and a good deal of ship work.

Concurrently with that there should be a definite co-ordinated attempt to investigate as fully as possible the various phenomena which have a bearing on conditions elsewhere, or are peculiar to the continent. This can only be done by the establishment of stations which can be occupied by the necessary parties of observers for long periods. Together with these definite problems come a host of minor ones, and also the continued though normally unsuccessful search for fresh resources which may be put to man's use. The economic aspect of exploration must be kept in view throughout, though in this case there seems little likelihood of any great discoveries being made.

In the past exploration has been carried out for the most part by private expeditions, which have done magnificent work and it is to be hoped will continue to do so. But there is a national and even an international aspect to the matter, and until that is fully recognised and an organised onslaught is made on the whole continent, a great part of the deeper scientific problems will have to remain unanswered.

BOOKS FOR FURTHER READING

The Lands of Silence. By Sir Clements Markham, K.C.B. (Cambridge University Press, 45*s.*)

This book contains accounts of the chief polar explorations, and gives references to the books dealing with the Antarctic. The *Geographical Journal* for March 1921 contains a lecture by the author on the future of polar exploration, delivered before the Royal Geographical Society.

Orthopædic Surgery

By A. B. Appleton, M.A., M.R.C.S.

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THAT special branch of surgery which is distinguished by the title "Orthopædic" is one of rapidly increasing scope and importance. This is largely an indirect result of the Great War, though actually dependent on new knowledge as to the behaviour of muscle and bone under altered conditions.

Previously concerning itself for the most part with deformities, especially those of children, it has now extended its sphere to include many conditions which are especially benefited by the application of its principles. Fractures are tending to become the special study of the orthopædic surgeon; tuberculosis of bones and joints is often now passed to him too, as one who must see to it that after cure there shall remain as little disabling deformity as possible.

Since, moreover, so much loss of usefulness in limbs was in the war directly due to injury of the nerves which control muscles, it has become necessary to develop the study of nerve repair, and of the muscular changes associated with injury to nerves.

The importance of rendering a wounded man as useful a member of society as possible is now realised as never previously, for the large numbers of the disabled render some solution of the problem of vital importance to the whole community. For the deformed in previous years pensions and institutionalism were the accepted fate; public opinion, indeed, conceived the man as helpless, and he in turn generally insisted on remaining so. Not but he sometimes found in his deformity a lucrative career. Witness the Court Fool or Jester. His lot, however, was a hard one; Christianity had brought a little amelioration, in almsgiving, but the Indians cast their cripples into the Ganges and the Spartans hurled them from precipices.

The problem of minimising defects and of educating the disabled to suitable occupations remained unsolved till this war. A start was made in 1914, by the Mayor of Lyons, who instituted the first training school for disabled soldiers; and somewhat later the need was met in this country by the establishment of large handicraft departments attached to special orthopædic hospitals. The combined "treatment and training" centres of to-day, administered by the Ministry of Pensions, represent our latest endeavours at providing a disabled man with a new and appropriate occupation, continuous anticipation of which is the duty of the orthopædic surgeon throughout the period of treatment.

Treatment, moreover, and training, are found to be of mutual assistance. Treatment gives far less satisfactory results if the recovering limb is not willingly and intelligently used by the patient.

The very earliest stages of the treatment of a wound have a profound influence over its future possibilities. It is hard in the later stages to undo the faults of earlier ones; and the unsatisfactory results attained when the time came to find occupations for the earlier war casualties led to the taking over by (Sir) Robert Jones of special responsibilities in the British Army for the cure of disabled limbs from start to finish. The United States Army was able to build where its colleague had laid the foundations, and from the beginning an organised attempt was made at the continuous supervision of men with injured limbs by expert orthopædists right from the line of battle.

Good ultimate function, is, then, the ambition of every surgeon engaged in orthopædic work.

The term "orthopædia" was employed as long ago as 1741 by Dr. Andry, Professor of Medicine in

the University of Paris. His book on children's deformities received this title (from ὀρθός, straight, and παιδίον, a child), and in this he anticipated modern views in his belief in carefully selected exercises for the prevention as well as cure of certain deformities. He would thicken the sole of a shoe, attach a weight to a crooked shoulder or massage a hunchback, as a logical outcome of his belief in the evils wrought by a faulty posture. In France, in fact, was born a realisation of the importance of muscle action in the shaping of bones. Delpech was next on the scene. He was the scientific bedside observer; and from a study of his patients he was driven to the conclusion that deformities such as club-foot must be attributed to unbalanced muscular action. So we find him in 1816, at Montpellier, performing the pioneer operation of tendon-cutting, or tenotomy, by which he released the deformed part from the unbalanced pull of the more active muscle (the tendon or "leader" being the means of its attachment to bone).

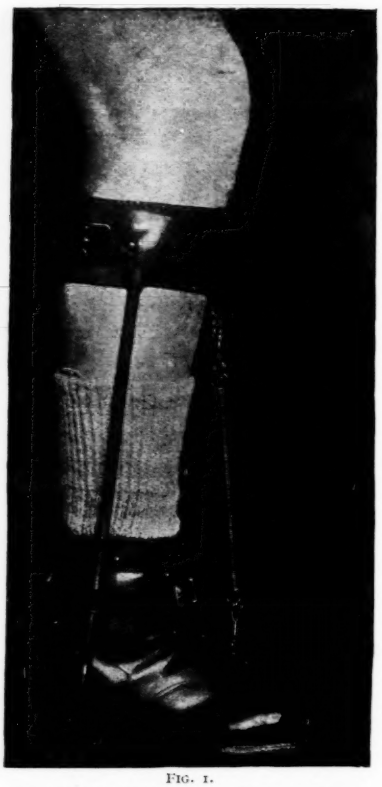


FIG. 1.
SPRING FOR DEALING WITH FOOT-DROP.
(Reproduced by permission of the *Oxford Medical Publications*.)

From its extreme simplicity, its great value, and the frequency of conditions in which such an obstacle to free movement is present, the operation with various modifications is still extensively employed. To-day, however, we must regard tenotomy in most cases merely as a remedy for conditions which were avoidable or preventable in the first place. Continued overaction of one set of muscles, with weakened muscles opposing it, brings about permanent shortening of the active set, and stretching with still further weakening of the less active; a vicious circle is established, and finally a fixed deformity of the joint is produced. Clearly the process should be recognised at its first inception, before definite secondary changes have occurred in muscles and neighbouring structures, and the onset of deformity should be prevented by support of the weaker muscles with splints.

A toe-raising spring is illustrated in Fig. 1, such as has been extensively employed for the prevention of deformity following foot-drop, a condition which occurs through injury of the nerve which supplies the toe-raising muscles. If such a case of foot-drop be left without support, the heel becomes more and more drawn up till eventually it gets fixed there by the shortening of the active calf muscles, and at this stage tenotomy above the heel must be an essential preliminary to any attempts to cure the toe-raising muscles.

To return to Delpech, we find that he had many imitators, and Stromeyer of Hanover was able, by adopting his idea, to relieve squint by division of certain eye muscles.

German surgeons next made a great forward step with the introduction of osteotomy—the division of bone by saw, or by hammer and "osteotome" (like a chisel with double bevelling)—a procedure by which the fragments may be made to unite in any desired alignment. It provides a means of placing the lower limb in a useful position, when, for example, hip disease has culminated in a fixed updrawn thigh. And other similar circumstances arise, the commonest being, perhaps, bending of the bones under the body-weight from rickets.

To-day an alternative procedure (osteoclasis) for children of three or four with the bent legs of rickets consists in simply breaking the bone across by hand without incision. But it is, of course, less exact. And though it appeals to some parents as being "bloodless," it is quite inadmissible when the "bend" has occurred near a joint. So-called "bloodless" methods, in fact, must be reserved for suitable cases, and each case must be judged on its merits. While it succeeds with the dislocated hips of little girls, it involves the gravest risks in old-standing shoulder dislocations. We may consider, then, that since the advent of Listerian Principles in Surgery, there is no reason whatever for avoiding the knife when better results are thereby obtained than by other means.

Consideration of the normal functions and require-

ments of the lower limb, and the contrast presented in these respects by the upper limb, which is not a supporting but a prehensile organ, has led to differentiation of the treatment meted out to the two limbs for similar injuries, or diseases. Mobility in an elbow is eminently desirable, whereas a fixed straight knee is of far more service than an uncertain movable one; indeed, an arm is rendered useless if the elbow becomes fixed in any position but a right angle (or near to it), and even then it is a poor imitation of the intact arm. Procedures (arthroplasty) have now been devised to restore mobility to a fixed joint where this is thought to be desirable; a new joint is fashioned and a flap of the soft tissues, muscle or fascia, is interposed to prevent reunion of the separated bones. Again, when required, anchylosis (fixation) of a joint may easily be brought about by the removal of a slice from the end of each bone, which bones are then steadied against one another till they have united; and in the lower limb such a procedure saves the child with paralysis from the need for wearing heavy and expensive apparatus to steady the joints.

A wide choice of operations, then, is now available for the treatment of joint and bone troubles; for the final selection from these special experience in these conditions is necessary if the maximum of usefulness in the limb is to be ultimately attained.

Fractures have recently been tending to fall within the special province of the orthopædic surgeon. A great variety of principles has in the past been adopted in their treatment.

At one time they were kept severely immobilised till union was assured. Later, Champonnière advocated movement and massage to obviate the stiffness which invariably followed from want of use of muscles and joints. But except where this treatment was carried out by his own specially trained masseuses, it was unsuccessful, because satisfactory union of the fragments was so difficult to attain. It is now recognised that close and correct apposition of the fragments does take precedence over all other considerations, but that at the earliest feasible moment, slight movements should be commenced—and the earlier the better; but no success in the preservation of healthy muscles and joints compensates for such a mechanical disability as a badly-set ankle.

Owen Thomas, the founder of the Liverpool School of Orthopædic Surgery, made a great advance when he devised the splints which bear his name for knee, hip, and arm, consisting of wire frames to steady the limb while yet permitting of an unimpeded circulation. Splints fashioned on this principle are to-day in widespread use; it will be seen what free access there is to the injured limb for the provision of massage and other active treatment.

The methods of Thomas were those of one who had discovered by 1880 the faults of the surgeons of his time, who gave insufficient rest to the limb; and one, further, who had perceived the fallacy of "manipulations" as practised by eminent bone-setters, and indeed previously by himself and his own father. These splints are of the greatest use for the control of the more awkward fractures, and with recent improvements are extensively employed.

Thomas's splints do not, however, provide for active movement of the injured part; and nowadays it is possible by various devices to provide suitable movements for injuries (including fractures) at a very early date. Especially is this necessary for a good result after an injury close to or involving a joint. Temporary support can be provided in a variety of ways until there is a minimal consolidation of the repairing tissue (known as callus). This may be by means of sandbags; or merely by strapping; or a plaster of Paris encasement may be prepared to fit, e.g., the leg for ankle fracture, with a hinge behind so that one side of the calf muscles may receive attention while the other side is supported by the splint. A recent method of preserving the health of neighbouring muscles in such cases as these is described later; the method, that of "graduated contractions," can be applied to the injured leg, even while this plaster splint is still being worn.

We find thus a germ of truth in the teachings of both Champonnière and Thomas; one of them guarded against subsequent stiffness due to neglect of muscles and joints; the other ensured sound if slow bone repair.

A radical method of assisting bone repair, mechanical fixation with plates and screws, or with wire, was advocated and practised originally by Sir Arbuthnot Lane. Only possible with the advent of Listerian surgery, it is even now limited to *healthy* limbs; soiled wounds necessitate complete healing before such an operation can be considered, owing to the extreme susceptibility of living bone tissue to the poisons produced by bacteria. This embedding of metal is inferior to one of the recent developments of bone-grafting: the employment of bone inlays which unite the two fragments. As compared with old-fashioned methods of treating bone-fractures, however, it was reported in 1912 by a commission of the British Medical Association that, for adults, Lane's method of fixation of the fragments was the most successful, but that in children better results were attained either by immobilisation or by mobilisation with massage. A considerable number of cases was investigated: 2,596 treated by immobilisation; but only 147 treated by operation were at that time available. The growing bones of children are liable to severe injury under

surgical procedures, the growth being liable to much retardation or distortion; and for this reason all types of bone-operation are generally avoided up to the age of about seventeen.

The recent tendency has been to reserve these operative procedures for cases where reapposition of fragments is very difficult to *maintain* in any other way; even the Liverpool school, which usually attains reapposition by powerful traction, and retention by Thomas's splints and their adaptations, finds scope for operative fixation where one fragment is small and uncontrollable—in their striving after true apposition and correct alignment.

A recently-introduced method of obtaining small muscle movements, suitable for maintaining a healthy condition during enforced rest, as immediately after a fracture, or again during the period of loss of power from nerve injury, consists in "treatment by Graduated Contractions." It is possible to obtain so small a contraction that the tendon merely stands out prominently without even producing a movement of the joint; and any required force of contraction may be provided with the greatest degree of accuracy. Such a method is obviously of the utmost value in maintaining muscles in good condition; for it is in *active use* that muscles find their best restorative; and it can be applied when it is still undesirable to allow of any joint movement, as in the early steps of treatment of a fracture. Contractions obtained by this method closely resemble ordinary voluntary movements. By this method, however, a *single* muscle can be made to contract, a feat which is extremely difficult of performance, and without practice almost impossible, under ordinary voluntary power. Any weakened muscle can thus be singled out for attention. A further advantage is that a small contraction is obtainable when none at all can be obtained by voluntary power; it can therefore be used to pave the way in a recovering muscle for movements of a voluntary nature.

It must be added that Graduated Contractions, graduated as to force with a scientific accuracy by the specially-trained masseuse, are greatly superior to *voluntary* contractions which are of much less certain force and amplitude, and are likely to do more harm than good in a recently injured limb.

It was by the recent elaboration after prolonged experiment of a special faradic coil that such Graduated Contractions have been made possible. The stimulus from the *ordinary* faradic coil is painful, and the patient inevitably resists. The coil which succeeds is practically painless in that it provides a secondary current of very low voltage, and that it has a perfectly regular action of the interrupter. The intensity of the stimulus is varied at will by pushing in or withdrawing the soft iron core which is found in the primary coil here as in an ordinary induction coil.[1] It may be noted in passing that the electricity is not employed for any general effect it may have on the body, but entirely to obtain the graduated muscular contraction which is the end in view. It is applied at certain spots on the skin of the limb, known as "motor points," of which there is approximately one for each muscle.

Slight cases of weakness in a muscle may be remedied by exercising this special muscle against such a resistance as a skilful masseuse can supply with her hand; and this method always becomes supplementary to Graduated Contractions in the later stages of muscle recovery; obviously, however, it is not available with a paralysed muscle; and, as mentioned above, it is an undesirable method of maintaining muscle tone when recent fractures or severe joint injuries are present.

The muscle-wasting which occurs in an immobilised limb, and which occurs much more markedly when the nerve or a neighbouring joint has been injured, has been in the past extensively treated by massage. Since, however, this does not in itself involve any active contractions, it is a very inferior procedure for the purpose in view. Massage acts directly on the circulation of the part and reflexly through the nervous system; it is suitable for quite another class of disorder. Passive movements, i.e. movements performed by the masseuse, who holds the limb, are also inferior in that active contraction of the wasted muscles is not an essential part of the procedure.

How very important is the procedure of graduated contractions will be realised when it is also recalled that in every case of joint injury there is severe muscle-wasting. Community of nerve-supply is responsible for a sort of "symbiosis," if we may borrow the term, between joint and closely associated muscles; if, for example, the knee-joint is affected, extreme wasting is liable to occur in the Vastus Internus, the muscle which forms the swelling just above the knee on the inner side.

Champonnière aimed at avoiding muscle-wasting and stiffness of the tissues during the treatment of fractures by "active" means—movement and massage. Now we are achieving, better than ever before, some of the results at which he was aiming, with the great advantages we now possess in delicate modern instruments for obtaining small muscle contractions, such as the specially wound induction coil mentioned above.

That muscles require such minute care during the treatment of a fracture is probably one of the chief considerations which is leading to the transference of such injuries to the orthopædic surgeon.

[1] See W. Rowley Bristow's book quoted at end of paper.

Many other unsatisfactory after-results of old-fashioned methods of treatment of injuries such as sprains, dislocations, etc., are attributable to the lack of care for the muscles during the process of recovery. A man, for example, is laid up for three weeks with a sprained ankle; he gets up, finds his foot "weak," and develops a flat foot. The fact is that the muscles supporting his instep have so far wasted that they are unequal to their task; the ligaments, next feeling the strain from the superimposed body-weight, give way, and the arch of the foot drops. Occurrences like these will become rarer and rarer, just as stiff limbs after fractures are becoming less common, in proportion as the newer principles of treatment become more widely understood and practised. There is not yet the same wide acceptance of the principle of early movements in the case of fresh sprains; many eminent orthopædic surgeons have adopted it, realising that here, as in the case of fractures, it is the extent and force of movement which determine disaster or success.

Treatment by graduated contractions with increasing amplitude of movement of the sprained joint, for twenty minutes daily, serves admirably to maintain muscle health and hinder the adhesion of the various tissues. All this at a stage when voluntary movements would be painful and quite inappropriate. For these fresh sprains there is, of course, everything to be gained by employing massage, also, for the removal of fluid in the swelling and for the alleviation of pain.

Sprains of "joints" (i.e. really of ligaments) and sprains of muscles are much relieved if the obvious procedure be employed of preventing tension on the damaged structure. The realisation of the value of this we really owe to the Liverpool school, and, like all Owen Thomas's methods, it is attained by quite simple means. At the ankle, the object can be achieved by "crooking" the heel with a $\frac{1}{3}$-inch wedge of leather on one or other side; but a "rider's strain," which under treatment by massage and strappings may prevent hunting for one season after another, is often amenable to nothing but a course of graduated contraction for the damaged muscle.

Of favourable terminations to acutely *inflamed* joints (as after penetration by a sharp instrument or projectile) anchylosis is at present commonest. While much more crippling in the upper than the lower limb, the limb may still be fairly useful if union of the two bones occurs in a favourable position. Intelligent anticipation in these cases as to the probable course of the case becomes of supreme importance; should a shoulder be likely to anchylose, it must be kept from the side at an angle of about 45°, a position in which, even with complete anchylosis, considerable and useful movements will be possible by movement of the shoulder-blade with arm in one piece.

Better than any anchylosis, or subsequent procedures such as the arthroplasty already mentioned, will be a method which aims at primary cure of the inflammation with a *movable* joint. Colonel Everidge has applied for inflamed (septic) joints a principle somewhat analogous to the employment of graduated contractions for muscles. Movements insufficient to cause injury, but adjuvant to the normal processes of repair, are obtained by an ingenious arrangement of pulleys (Fig. 3), very slowly and steadily moved by the running of sand through the balancing weights; and movable joints result where immobilisation would inevitably have ended in anchylosis. Belgian surgeons have obtained similar successful results; but further experience is necessary to determine the scope and limitations of this promising procedure.

The employment of X-rays is of great value in orthopædic surgery as in general surgery, but especially so because so much of the surgery of bone falls within the sphere of the orthopædist. Recently the regular employment of X-rays has revealed the fact that many supposed sprains are complicated by fractures which would be unrecognisable by other methods of diagnosis. Previously there had been extreme uncertainty as to the prospect of good ultimate cure in these "sprains"; the assistance thus provided by X-rays is rendering far easier the determination of the proper date at which, for example, weight should be permitted upon an ankle, sprains and fractures being so different in this respect. Wrist and finger "sprains" are, it has been discovered, frequently complicated by such unobtrusive fractures, very disabling, however, when treated by too prolonged rest or, on the other hand, by too early and too vigorous treatment.

For watching the fate of bone-grafts, for studying the condition of bones and their relationship to surrounding parts, the use of X-rays has been one of the chief factors in the recent progress of bone-surgery. Adhesions, whether between joint-surfaces, between tendons and the sheaths within which they run, or between muscles and surrounding structures, are all the result of immobilisation, of lack of the natural movements of the part. Three weeks of this treatment will incapacitate a healthy knee: how full of risk, then, when neighbouring injuries have occurred, with their associated swelling, and processes occur which prevent absorption. Adhesions are liable to form after unrecognised injuries of the joint surfaces from small complicating fractures. After the lapse of time, movements become less painful, but in certain positions the pain is still liable to occur from tugging upon the fibrous band into which, by repeated move-

ments, the adhesion has been stretched. Now, the recognition of these adhesions is sometimes difficult, but the importance of their diagnosis is beginning to be realised; for by complete rupture of adhesions, relief is obtained; by incomplete rupture, the condition is only aggravated through the injury inflicted. Hence, to borrow a formula of the old bone-setter, Hutton, in speaking of deranged knee-joints, "pulling is of little use; it is the twist as does it." The long history of that ancient British practice "bone-setting," with which was associated in former days the practice of the "professional rubbers," teems with examples both of success and disaster following the same methods of treatment. The method of treatment was, in fact, regarded as a personal or family secret, so that we can appreciate what it meant to Hutton when he imparted to Dr. Peter Hood (who gratuitously attended him in an illness) all the secrets of his art. After Hutton's death in 1871, Dr. Wharton Hood, the son of Dr. Peter Hood, following the usual practice of the medical profession, made public all he knew of the art, as exemplified in Hutton's methods, and he showed how Hutton profited by the failure of so many of the medical profession of his day to gain a real understanding of joint troubles.

(To be continued.)

BOOKS OF REFERENCE OR FOR FURTHER READING

(1) *Treatment of Joint and Muscle Injuries.* By W. Rowley Bristow. (Oxford University Press, 1917, 6s.)
(2) *Menders of the Maimed.* By A. Keith, M.D., F.R.C.S., F.R.S. (Oxford University Press, 1919, 16s.)
(3) *The After-Treatment of Wounds and Injuries.* By R. C. Elmslie, M.S., F.R.C.S. (J. & A. Churchill, 1919.)

The Optophone[1]

By Edward Cahen, A.R.C.Sc., F.I.C.

BLINDNESS, and all that it means, has always provoked more sympathy than any other deprivation to which man is subject, and of all the tragedies of war, perhaps the greatest is the sudden veil of darkness which has descended on so many of our soldiers and sailors. Marguerite Radcliffe-Hall[2] has endeavoured to express the consolation of inward vision supposed to be possessed by the blind in a song which has been set to music by Robert Coningsby Clarke:

"Set my hands upon the plough,
My feet upon the sod:
Turn my face towards the east,
And praise be to God!
Ev'ry year the rains do fall,
The seeds they stir and spring;
Ev'ry year the spreading trees
Shelter birds that sing.
From the shelter of your heart,
Brother, drive out sin;
Let the little birds of faith
Come and nest therein.
God has made His sun to shine
On both you and me;
God who took away my eyes,
That my soul might see."

Exquisite as is the sentiment expressed in these few beautiful lines, they offer but little practical help to the sightless, who, no longer being able to read, are deprived of one of the greatest consolations in suffering and trouble it is possible to imagine.

Up to the present time, the only way in which the blind might read was by feeling the letters in specially embossed books. These books, printed in the Braille system, were a great boon to blind readers, but this method of printing books was not only cumbersome, but also very costly, and reading was a very slow process. The optophone, which was invented by Dr. E. E. Fournier d'Albe, of London, in 1912, and has been since modified and developed by Messrs. Barr & Stroud, of Glasgow, has successfully overcome these disadvantages. The optophone enables a reader to read ordinary printed matter, such as books or newspapers, by listening to the letters in a telephone. As the instrument traverses a line of print, each letter produces in the telephone receiver a series of musical notes forming tunes or musical motifs. As the majority of blind people have a good sense of hearing, it is not long before each letter in the alphabet is identified with its musical motif in the receiver, and in this way the words and sentences formed from the letters can be read. When the sound-alphabet has been learned, the more extended motifs for syllables and even words becomes familiar to the reader's ear. Just as a telephone operator can interpret easily a succession of clicks on the Morse code, so the optophone reader recognises words in his instrument. Already it has been found with the latest type of optophone that a blind reader after some practice has attained a reading speed of twenty-five words a minute. This is, of course, a slow speed compared with the rate at which we read, but it is an extremely hopeful one. The ideal optophone would be an instrument which sounded the very letters of the word read, or the words themselves, but this instrument has still to come. Meanwhile, the blind man may read by means of the musical motifs.

[1] The Editor wishes to thank Messrs. Barr & Stroud, of Glasgow, for their kindness in furnishing him with the illustrations in this article and for their courtesy.

[2] *Songs of Three Counties and Other Poems.* (Chapman & Hall, 1913.)

The principle upon which this instrument is based depends upon the vagaries of the substance selenium, an element which is closely allied chemically to sulphur, with which it is often associated in nature, and which is regarded as an unmitigated nuisance by the manufacturer of sulphuric acid, because it spoils his acid for use in the paper-making industry. Selenium was formerly obtained as a waste product from the lead-chamber process of making this acid, but it is now obtained almost exclusively from the electrolytic smelting of copper, which is carried on chiefly in the United States. The fact that is made use of is that the electrial conductivity of selenium in one of its physical forms varies greatly in accordance with the amount of light which falls upon it. This was first noticed by Willoughby Smith and his assistant May, who were carrying out some cable-testing experiments on the Island Station Valentia, off the coast of Ireland, in the year 1873. May could not get the results from his instruments by day to agree with those by night. He therefore came to the conclusion that there must be something peculiar in the way this element selenium behaved when an electric current was passed through it. It had long been noticed that selenium offered a very great resistance to the passage of the current, but it had not been observed that *the degree of resistance was affected by the amount of light falling on it.* It is this peculiarity of selenium that is the basis of the optophone.

Writing to a friend early in 1873, Willoughby Smith tells of his discovery in rather a witty and graphic manner:

"With the assistance of a microphone one can hear the footsteps of a fly as loudly as if it were the tramping of a horse on a wooden bridge; but it strikes me as much more wonderful that by means of a telephone I can hear a ray of light falling on a metal plate."

When light falls upon selenium prepared in a special way, a change takes place in its conductivity, and this change occurs almost instantaneously. It is the rays at the red end of the spectrum which are most efficient in bringing about this change. The conductivity is nearly double in sunlight what it is in the dark. When the source of light is removed, the drop in conductivity occurs very rapidly.

To get the maximum effect from a small amount of material, the selenium must be prepared in a special form. Great ingenuity has been displayed in attacking this problem. Graham Bell, the inventor of the telephone, was the first to make a reliable selenium cell, as it is called, though Werner Siemens three years earlier, in 1875, had made an attempt. Presser in 1909 first produced one of the up-to-date cells, and Fournier d'Albe followed with his two years later.

Presser's cell consisted of a circular piece of steatite (a silicate of magnesium) covered with platinum and engraved in concentric rings. The whole surface was then covered with molten selenium. Fournier d'Albe's cell is simpler still, and far less costly. He uses a small plate of unglazed porcelain about one inch square; this is covered with graphite, and then engraved in fine grooves from side to side, close together, and slightly inclined, like the one in Fig. 5 below. The whole is finally coated with molten selenium, with the exception of a small margin on each side to serve as the electrodes. These natty little structures have received the distinctive name of selenium tablets from their originator. They are very strong, and cannot

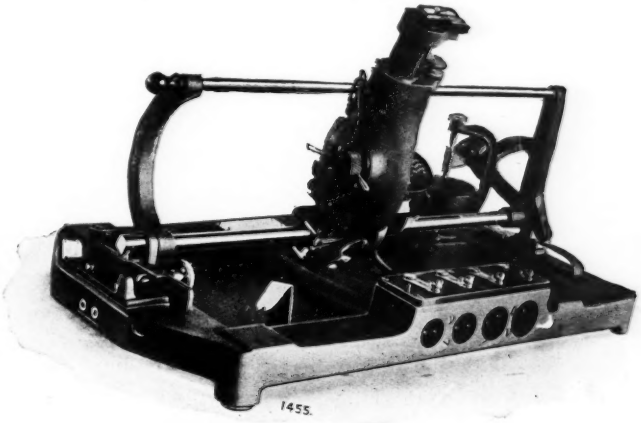


FIG. 1.
THE OPTOPHONE WITH BOOK-REST REMOVED.

easily be damaged; furthermore, owing to their small size, they can be suitably mounted in any way for the purpose in hand. It is a modification of these little tablets that is the actuating principle of the optophone.

Now, if an ordinary telephone receiver be connected in series with an electric battery and one of these selenium tablets, a current will pass through the tablet, and the current will vary as the light falling on the tablet varies, since this alters its conductivity. The tablet is called a "selenium bridge." When flashes of light are thrown on to the selenium bridge at a rate of 256 per second, the current will rise and fall at that rate, and the telephone will sing out the note middle C of the piano. If the pulsations of the light are at half that frequency, that is, 128 per second, the telephone will sing out C an octave lower, and, with double the frequency, 512 pulsations per second, the C one octave higher, and so on. The rate at which these pulsations are sent out can be varied as required, and so a note agreeable to the listener may

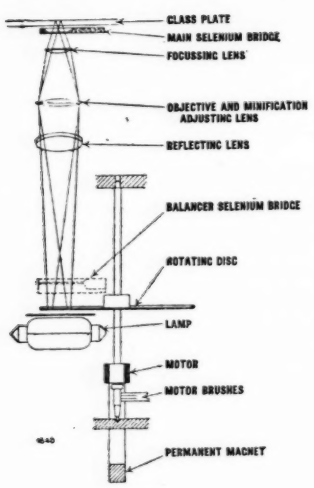


FIG. 2.

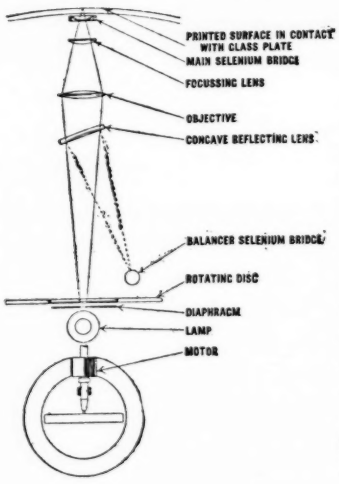


FIG. 3.

DIAGRAMMATIC ARRANGEMENT OF OPTOPHONE.

be obtained. These are, of course, well-known facts. It is the rôle played by the selenium which is the novel feature.

In the optophone a selenium bridge is exposed to successions of sets of light pulsations, which vary according to the forms of letters as these are passed over in traversing a line of printed type, each letter being indicated in the telephone by a characteristic motif comprising successions of single notes and chords. And the letters of this sound alphabet can be readily learned.

The optophone is quite small, not much bigger than a portable typewriter, and externally (Fig. 1) there is not much to be seen, just a glass table on which the book or other printed matter rests face downwards. To understand the mechanism of the machine, the reader must glance at the diagrammatic views of the mysteries hidden away under this table. Each letter is illumined in turn by the light which is thrown up from beneath, and which is made to travel along the lines of print by a specially designed variable speed governor. The source of light is a small straight electric filament lamp (Figs. 2 and 3), the rays of which are made to pass through a diaphragm on to a perforated disc (Fig. 4), which is caused to rotate rapidly by means of a small magneto-electric motor driven from secondary cells. The light which passes through this disc is directed by suitable lenses on to the printed page, and traverses an aperture in the selenium tablet which is placed directly under the glass table. As this tablet travels along with the rest of the optical apparatus to which it is attached, it catches the light diffusely reflected from the white paper surrounding each letter in turn. This the makers call the "main selenium bridge," to distinguish it from the "balancer bridge," the object of which will shortly be explained. Both these bridges are shown in their various stages of production in Fig. 5. The graphite areas are simply pencilled on, leaving the "lane" of bare porcelain between. The tablet, or bridge, is afterwards smeared with selenium paste and annealed. The actual working principle of the instrument is as simple as it is ingenious: the light which passes the five rings of perforations in the rotating disc falls on the printed matter as five dots in a row, and is known as the "scala" (Fig. 6). Each spot pulsates at a rate corresponding to the number of the perforations in the particular circle to which it belongs, multiplied by the number of revolutions of the disc per second. The circles are provided with 18, 24, 27, 30, and 36 holes respectively, from the centre outwards. The pulsations of each spot of light are translated into a definite musical note in the telephone attached, the pitch of the note varying according to the speed at which the disc is rotating, but the intervals, which are those between the notes G, C^1, D^1, E^1, G^1 (soh, doh, ray, me, soh), remain the same, whatever this speed may be. There is a focusing arrangement which adjusts the width of the scala to the size of the print, so that as the scala passes over the type, combinations of the musical notes are given out, forming a motif which is peculiar to each letter, and which can be heard in the telephone connected with the main selenium bridge as mentioned above.

FIG. 4.
ROTATING DISC.

In this instrument all the notes are sounded at once, producing discord when a sheet of white paper is laid on the table, and on the contrary there is dead

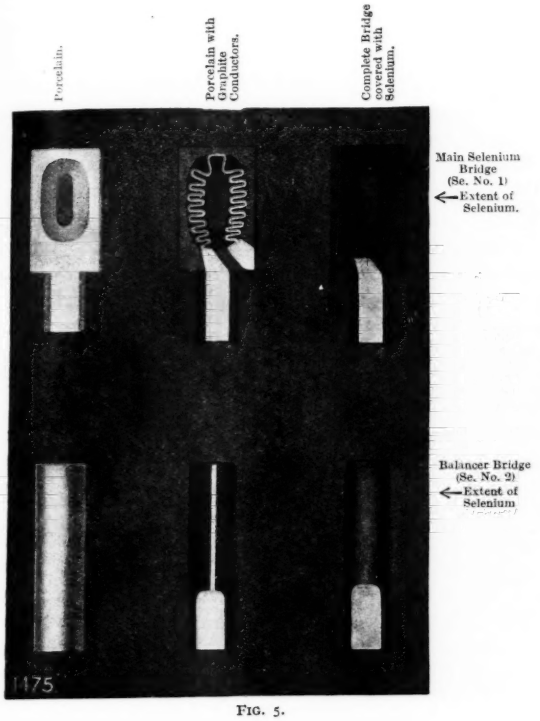


FIG. 5.

silence in the telephone when a piece of black paper is substituted for the white. If the scala passes over the letter V, for example, the top note (high soh) will first be silenced, then me, ray, doh, ray, me, and soh in succession. Such an instrument is therefore referred to as a "white sounding optophone," for the reason already explained, that it is the white spaces around the words which form the musical motifs. The newest optophones have been so modified by the introduction of the balancer bridge, of which we have already spoken, so as to "sound black."

In this case white paper produces silence in the

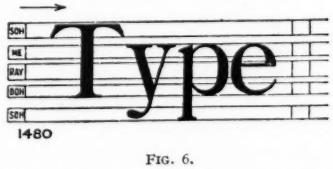


FIG. 6.

SCALA PASSING OVER PRINTED LETTERS.

telephone, and each black letter has its own musical motif, which can be distinguished and learnt with much greater ease by the blind reader, as they are far more characteristic than the motifs produced by the white spaces surrounding the letters in the older type of machine. With this instrument the letter V is represented by the motif soh, me, ray, doh, ray, me, soh.

How the two selenium bridges are connected to the battery and telephone is seen at a glance in Fig. 7, and the working of the balancer is explained by the makers in a booklet on the optophone, published by them, from which I have quoted, and from which they have kindly allowed me to reproduce the various figures illustrating this article. "The balancer is illuminated by a small part of the intermitted light reflected aside before it reaches the paper, and is so connected to the telephone and battery that the current traversing the balancer bridge acts in the reverse direction in the telephone to that of the current through the main selenium bridge. The

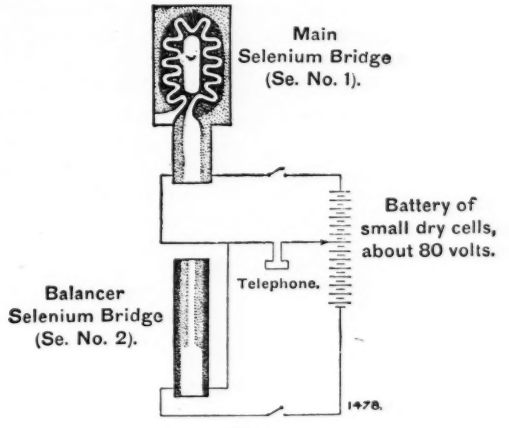


FIG. 7.

DIAGRAM OF SELENIUM BRIDGE CONNECTIONS.

balancer thus tends to cause the telephone to sound all the notes continuously, and the main selenium bridge, that receives the light reflected from the paper, annuls the effect on the telephone in respect to any note when the spot of light corresponding to that note falls on white paper. The division of the total voltage of the battery can be varied, so that when the whole scala falls on white paper, the telephone is silent, and notes are sounded only as the scala moves over the black letters."

One of the finished instruments was shown at the Scientific Products Exhibition at the Caxton Hall in the summer of 1919, and since then the optophone has become quite a feature of all exhibitions where British post-war industry is to be seen. It seems a fitting atonement that a firm which formerly devoted itself to instruments of precision for use in warfare (the range-finder, for example), should make an effort to

repair the ravages that war has created, for, needless to remark, the optophone is being used to offer some consolation and relief to those officers who have lost their sight in their country's service.

Further information on this subject may be obtained from Pamphlet 236, issued gratis, in May 1920, by Messrs. Barr & Stroud, Ltd., Anniesland, Glasgow.

Problems of Arctic Discovery

R. N. Rudmose Brown, D.Sc.

THE attainment of the North Pole in 1909 by the late Admiral Peary has not, as some people idly suppose, put a check on Arctic exploration or in any way lessened the desirability of its continuance. The result of that fine feat of organisation and endurance has been to turn exploration into less sensational and so perhaps less popular channels, but at no period since the date of Peary's success have the Arctic regions been deserted by explorers. Canadians, Americans, Danes, Norwegians, and Russians have done a remarkable amount of successful work during the last decade, and now Sir Ernest Shackleton proposes to use his long Antarctic experience in the solution of certain Arctic problems.

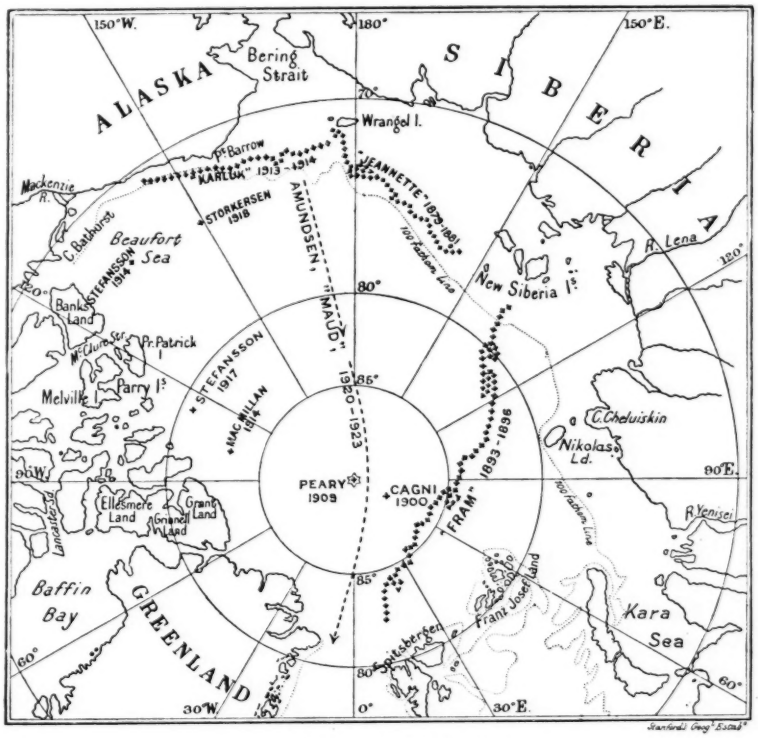
During the years 1908 to 1918, V. Stefansson and his staff were busy exploring the western islands of the Canadian Arctic Archipelago, discovering several new ones and amplifying and correcting earlier charts. Americans under D. Macmillan from a base at Etah in north-western Greenland, from 1913 to 1917, did much work in Ellesmere Land, touching on Stefansson's sphere in the south-west. Erichsen, Mikkelsen, Rasmussen, Koch, and other Danes have continued the fine record of Danish explorers in Greenland, and almost completed the mapping of the coasts of that island. Russians have most successfully re-explored the north coasts of Siberia and adjacent islands, making considerable changes in the map and accomplishing, in Vilkitski's voyage in 1914–15, the second traverse of the North-East passage and the first on record from east to west. Lastly, to mention only the outstanding achievements, Roald Amundsen, the Norwegian discoverer of the South Pole and the first navigator of the North-West passage, made the North-East passage in 1918–20 and arrived safely in Alaska, only to leave again for the north to emulate with his vessel, the *Maud*, Nansen's drift in the *Fram*, hoping to pass across the heart of the Arctic Ocean.

While scientific research in geology, meteorology, magnetism, oceanography, and other sciences is the most fruitful aspect of exploration, it must be remembered that no modern expedition, properly staffed and equipped, ignores these sides of its work, even if its main task is to penetrate the areas which are still blanks on the map. The scientific results of an expedition are the most important, but they fire the imagination less than the discovery of new lands, and after all, eager as the explorer is to probe the problems of his special science, the lure of the unknown and the spirit of adventure are the prime motives that send him to his quest. Those of us who have been fortunate enough to take part in such work know quite well that adventure pure and simple, and not scientific curiosity, led us first to polar regions. On a recent occasion Sir Ernest Shackleton very truly said: "One goes out mainly for the adventure of it, and to hide oneself behind the cloak of science is not quite honest."

It might appear that, in view of the expeditions mentioned above and the work of the previous century, there is little discovery to be done in Arctic seas, even if a great deal of careful exploration is required. But that is not the case, and fortunately for the adventurous spirits who find their fascination in polar regions, there are still certain areas of the Arctic Ocean which may hold hidden islands, and in any case afford ample difficulties for the ambitious explorer who seeks to traverse them.

With the exception of the *Fram* and the *Maud*, all exploration of the Arctic Ocean has been conducted by advances more or less successful from ships or land bases. The aim generally was to have a land base as far north as possible, and hence Spitsbergen, easily accessible, Greenland, and even Franz Josef Land, were favourite starting-points. It was by using Cape Columbia in Grant Land, almost the most northerly land known, as a base from which to make a dash of 826 miles to the Pole and back that Peary achieved success. Attempts of this nature, previously all directed to the Pole itself, left on one side the Arctic Ocean north of Alaska and eastern Siberia through 180° of longitude. No land is known in a high latitude on that side of the Arctic Ocean. There are other contributory reasons for the neglect of this area. It is inaccessible to ships except by Bering Strait or the difficult and uncertain North-East passage, and in consequence lies far distant from the enterprising exploring nations of the Atlantic sea-board, circumstances that are now modified to some extent by the opening of the Panama Canal. Furthermore, the narrow and shallow Bering Strait, by excluding the warmer waters of the Pacific, results in the ice-bound sea extending much farther south on the Siberian and Alaskan than on the European and Atlantic sides of the Arctic Ocean.

The *Maud*, imprisoned in the drifting pack-ice which sets with the current towards Greenland and Spitsbergen, will probably cross the heart of the polar basin, advancing approximately along the meridian of 180°. But between that longitude and the Parry Islands there remains a vast area north of about lat. 74° N. that has never been entered, unless perhaps some unrecorded American whaler has seen his chance in an open season and pushed north. Roughly speaking, this may be termed the Beaufort Sea, although that name is more strictly applicable only to its south-eastern part. This will prove a difficult region to explore. Stefansson maintains that what he calls the pole of inaccessibility in the north lies in lat. 83° 50′ N., long. 160° W., that is, 370 nautical miles from the geographical pole on the meridian which passes about 80 miles west of Alaska's most northerly cape. The drift tactics of Nansen and Amundsen might be tried, but with less hope of success than farther west, at least until more is known of the currents. More than one whaler caught in the ice has disappeared in this sea never to be heard of again. De Long's *Jeannette* in 1881 and Bartlett's *Karluk*, the latter destined in 1914 to explore this sea as part of the Stefansson expedition, both drifted westward and northward in the southern part of this area of the Arctic Ocean until crushed in the ice. (It must be remembered that neither was built of sufficient strength to withstand heavy ice-pressure.) Stefansson, in crossing the south-eastern end of the Beaufort Sea, found a continuous south-westerly drift. Other evidence is in favour of an easterly set which packs the ice against the Parry Islands, Grant Land and Greenland. More than one explorer has penetrated 100 miles or more into this region from the land to the south or east, but there is space for large islands to be hidden in this unknown sea. What is the likelihood of land existing there? On the whole very little. The few soundings taken north of Bering Strait and Alaska are in favour of a narrow continental shelf and a sea floor falling rapidly to the great depths of the Arctic Ocean, although west of the Canadian Arctic Archipelago the evidence is less conclusive. Evidence deduced from the drift of the pack-ice and the course of the tides is also opposed to the existence of land in this area. Keenan Land, vaguely reported from whaling sources in the seventies of last century, was practically disproved by Storkersen's sledge journey from the coast of Alaska to lat. 73° 58′ N., long. 147° 50′ W. in 1918, and Crocker



SKETCH MAP OF THE POLAR REGIONS.

Series of crosses mark drift of ice-bound ships: single crosses indicate furthest advances into unexplored area of Arctic Ocean between Alaska and the North Pole. The probable course of Amundsen's drift is shown.

Land reported by Peary in 1906 to be some 150 miles west of Grant Land, could not be found by Macmillan in a sledge journey in 1914. Dr. Cook's report of land on the same meridian in lat. 85° N. can scarcely be taken as evidence of its existence. Nevertheless, that stretch of Arctic Ocean offers a fine field for the pioneer explorer.

Another but much smaller area of the Arctic Ocean that should be examined for possible land lies between Spitsbergen and Franz Josef Land, from lat. 80° N. to 84° N., the so-called Victoria Sea. There is more than one report of high land sighted in that region, of which the least unconvincing was that of the late Admiral Makaroff, of the Russian Navy. When testing the ice-breaking qualities of the *Yermak* in 1899, Makaroff went north of Spitsbergen in search of heavy ice, and in the course of his cruise reported high land seen in refraction at a distance of 60 to 100 miles, on about the thirtieth meridian and in about lat. 82° N. Curiously enough, this is about the locality to which Giles Land, discovered in 1707 but not explored till nearly two centuries later, was unaccountably displaced by Petermann, the German cartographer, from its true position some two degrees farther south. The pack-ice drifting from the north-east makes this part of the polar sea difficult to penetrate, but quite possibly some Norwegian hunting sloop in a favourable season has crossed it. There used to be a rumour among the walrus hunters of a large island to the north-east of Spitsbergen, but the story lacked substance and was generally discredited. The existence of islands at one time reported north of Franz Josef Land has been disproved, but at the same time the occurrence of small islands east of Spitsbergen and the extension of the continental shelf a short distance north of Spitsbergen shows that there is nothing intrinsically impossible in hidden islands existing in this sea. On the other hand, there cannot be much land between the meridians of western Franz Josef Land and eastern Spitsbergen, owing to the freedom with which pack streams southward on the east of the Spitsbergen archipelago and its speed of movement north of Franz Josef Land. The northward extension of Nikolas Land, north of the Taimir Peninsula, Siberia, requires further investigation. The unexplored area of the ocean north-east of Greenland, which offers little likelihood of land, will probably be visited by Amundsen on his present expedition.

Apart from the task of penetrating the ice-bound seas, other difficulties not quite so obvious present themselves.

It is possible in polar regions to be very near land without seeing it. Fog may be a hindrance, but even in clear weather it must be remembered that the horizon is at no great distance from the deck of a small ship. If the sea is clear of ice there is probably no lookout in the crow's-nest and low land might escape detection. A most striking and almost incredible instance of an elusive land is the little-known Nikolas Land, which lies north-west of Cape Chelyuskin, the most northerly point of Siberia. Several exploring vessels on the lookout for land had rounded this cape, including the *Vega* in 1878 on her circumnavigation of Asia, and Nansen's *Fram* in 1893, but reported only sea to the north. Great was the surprise, therefore, when the Russian ice-breakers *Vaigach* and *Taimir*, under Com. Vilkitski, in 1913 discovered a considerable extent of high land and two small islands some thirty miles north-west of Cape Chelyuskin. This discovery shows that it is unsafe to remove a reported land from the map merely because it has escaped rediscovery by vessels or sledging parties in the vicinity.

The Russian ice-breakers in 1913 and 1914 crossed the position of the reported Sannikov Land to the north-west of the New Siberia Islands and saw no land. The *Fram* in 1894, passing on the west, failed to sight it. We are probably justified in saying that it does not exist. Yet a snow- or ice-clad land may merge so effectively into a background of cloud as to be almost invisible. Every voyager to and from Spitsbergen knows how Bear Island, full on his track, eludes his view despite its height of 1,760 feet. On the other hand, nothing is commoner in polar seas than the appearance of land which on closer examination turns out to be a cloud or mirage effects. Even experienced polar voyagers are thus deceived at times, while the novice discovers new land every day.

It must not be forgotten that many doubtful lands have been reported from a great distance and placed by one bearing which, even if the compass is accurate and the magnetic variation known, is at best an unsatisfactory way of locating a position. Distance in polar regions is very deceptive. In fine weather the transparency of the atmosphere is so marked that long distances appear quite short and, provided the land is high enough, it can be seen 100 miles or more away with great ease.

The methods of Arctic exploration have changed since the days, not half a century ago, when weak-powered vessels contested with the pack-ice, and large sledging parties heavily laden with stores and dogged by scurvy made heroically laborious marches into the unknown. Dogs were rarely used, although Wrangell a century ago showed what could be done with them. Even after Rae showed the advantage of travelling with small parties and making use of dogs, the practice of man-hauled sledges persisted. Sir Leopold M'Clintok, a pioneer in successful Arctic sledging, was one of the few explorers to follow Rae's example until the days of Peary and later Scandinavian explorers. The marvel

is that these early expeditions achieved so much, burdened and hampered as they were in their movements. Their achievements speak volumes for skill in seamanship and high endeavour and great endurance in travelling. Dr. John Rae, the discoverer of the fate of Franklin and his men, had great success as an Arctic sledger, because he utilised dogs for traction, and depended largely on the game the country provided. Thus he was enabled to travel light with small parties, and succeeded in covering great distances at high speed with a minimum of exertion. Large parties are at a disadvantage whether the provisions are carried or obtained by hunting on the way. Nansen, in his fine journey from the *Fram* to Franz Josef Land in 1895, travelled with one companion, and during their wintering the two lived on little else than the produce of the sea.

Peary was a believer in small parties, but his practice of carrying with him practically all his provisions necessitated a system of supporting parties. His dash to the Pole in 1909 was at an almost incredible speed: sufficiency of food and lightness of load could be combined only through speed. Sverdrup, Isachsen, and other Norwegians did notable work by small parties with dog sledges. It was left for Rasmussen and other Danes in Greenland, and particularly Stefansson in Canadian Arctic islands, to perfect the method of "living by forage" and travelling light in small parties. So successful has Stefansson been by these means that he has been able to stay long periods cut off from a base without suffering any inconvenience. Even tea, coffee, and tobacco are dispensed with. On one occasion Stefansson left the shores of Alaska to cross the south-east of the Beaufort Sea, a journey which took him 96 days, with two weeks' provisions, but suffered from no lack of food. To him the seal is a source of food and fuel, and he has shown that their numbers have no direct relation to latitude. They are frequent in most parts of Arctic seas, even if "ice deserts," places devoid of seals, occur, and necessitate a dash to escape starvation unless some reserve meat is carried. Not only does this method of living immensely lighten the explorer's task, but also it prevents all risk of scurvy, and Stefansson has shown that an exclusive meat and blubber diet, even without salt, is in no way harmful to health or destructive of powers of endurance.

While Arctic sea-ice on the whole lends itself to sledge travelling, because of the land-locked nature of the polar basin, there are great difficulties to be faced which in places are almost insuperable, as many an early explorer found to his cost. Open lanes of water may always be encountered, especially near the edges of the pack where the ocean is widest, but are relatively unlikely off the Parry Islands, Ellesmere Land, Grant Land, and Greenland. Pressure ridges are great obstacles near land, especially north of Greenland. But most troublesome of all is the drift of the pack which in some parts is so considerable that no journey against the drift is likely to make headway. In 1827 Parry had to abandon his attempt to attain a high northern latitude by sledging north from Spitsbergen, because the southerly drift nullified all his efforts; and in 1900 Cagni, on his return from his northern record, lat. 86° 33′ N., had great difficulty in regaining his base in Franz Josef Land owing to the drift carrying him to the south-west.

On the other hand, advantage can, of course, be taken of the drift in planning a journey, now that its general direction is known. It is in this way that the most successful explorations of the Arctic Ocean have been made, as in the case of the *Fram*. Amundsen in the *Maud* should turn up near Greenland in two or three years' time.

Ice-breakers have some small value near the edge of the pack, but experience has shown that they cannot penetrate far, and are unable to make much impression on ice of several years' growth. For several seasons Russian ice-breakers explored the Siberian fringe of the Arctic Ocean, but were unable to escape the necessity of either wintering ice-bound or retreating in autumn.

For a discussion of V. Stefansson's methods of exploration, see his articles in the *Geographical Review* (New York), especially October 1918, May 1919, and September 1920. Reference should also be made to a recent article by F. Debenham: "The Future of Polar Exploration," *Geographical Journal*, March 1921. For trustworthy accounts of the history of polar exploration the best books available are—(Arctic) *Handbook of Polar Discoveries*, A. W. Greeley (Boston, 1907); (Antarctic) *The Siege of the South Pole*, H. R. Mill (London, 1905). Later works do not equal these in completeness and accuracy.

Plant Hygiene

By George C. Gough, A.R.C.Sc., B.Sc.

BLIGHTS and pests on plants are no new things, and they are mentioned in the earliest books on agriculture and horticulture, but little or nothing was known as to their cause; in fact, they were looked upon as a visitation of God.

The term "blight" is still commonly used in a general sense, although, nowadays, it is chiefly applied either to attacks of "green fly" or to ordinary potato disease. In the country it was by no means uncommon for dull, misty days to be looked upon as caused by blight, and the natural corollary of this view was that nothing could be done to save a crop when it was

subject to an attack of blight, if it were in such an amount as to darken the air. The east wind also gets credit for bringing "blight," and this is no new idea. Witness the blasting of the ears by the east wind in Pharaoh's dream.

When, however, some knowledge of the life-history of the various pests and diseases found on plants was obtained, attempts were made to check at least the damage done. At an early date various poisons were used as insecticides, such as solutions made by soaking tobacco or by dissolving soap, and the accidental discovery of "Bordelaise" gave an impetus to spraying generally.

Bordelaise, or Bordeaux mixture, as is well known, was first used to cover grapes growing alongside paths and roads to prevent "finger blight." It was discovered, however, that vines treated in such a way were free from attacks of mildew, and the habit of spraying the whole of the vineyards with this mixture of blue vitriol and lime became general. Later it was found that it not only prevented attacks of mildew on vines, but many other diseases caused by fungi on plants generally. Nowadays it is commonly used to prevent attacks of ordinary potato disease (Phytophthora).

With the increase of spraying, came the development of spraying machines for distributing the fluids, originally put on in a primitive way by sprinkling it on the plants with a brush of twigs. Nowadays a big industry has sprung up, and all kinds of machines, from small hand-pumps suitable for an amateur's greenhouse, to large complex motor-tackle for use on farms, are produced. In addition, numerous firms have specialised in the providing of suitable sprays and washes, and other material connected with the checking of plant pests.

Old growers frequently say that there were not so many pests in their young days. As a matter of fact, most of the pests abundant at the present time were present, but not in sufficient numbers to attract the ordinary growers' notice. On the other hand, there has been an increase in the opportunity for the spreading of such pests. Half a century ago, orchards were scattered and few in number. Since then, especially in certain districts such as Kent, Wisbech, and Worcestershire, the planting of fruit trees has gone on to such an extent that orchard meets orchard for miles, while plants have been collected from all countries. It is, therefore, not surprising that pests which were confined to isolated districts, with a limited amount of food material, made the most of their opportunity. The great increase of food plants enabled them to perpetuate themselves on a large scale. Coincident with this, nurserymen and others have introduced plants from abroad with their respective pests, and in many cases the pest has not been content to remain on its original food plant, but has adapted itself to other varieties, so that new pests on our native plants have been introduced. In some instances, good examples being American gooseberry mildew and wart disease of potatoes, these pests have made the industry a precarious one, and great losses have been incurred.

Growers on a commercial scale have been passing through a period where pests were unheeded until obvious damage was done, and have then attempted to check or kill the pest by spraying. The latter will still be necessary, but nowadays efforts are being made to lessen the labour involved by a little forethought on the part of the grower. He is finding that it pays him to learn the life-history and appearance of the enemies of his crops, so that he can not only recognise them at an early stage in their existence, but also know the most vulnerable point in their life-history. Such knowledge tells him that general untidiness and carelessness in the orchard and field means the propagation and protection of his enemies. Hence the science of Plant Hygiene is coming into being. "Prevention is better than cure" applies here as elsewhere.

As an example of the help given by a knowledge of the life-history of a pest, that of the winter moths might be quoted. These moths, as their names imply, are in the moth or adult stage during the winter months, and they are singular in having females which are wingless, or practically so, and which therefore cannot fly. In order to lay their eggs they have to climb up the trees, and most trees are a prey for them. Up-to-date growers take advantage of this stage to place around the trunks of the trees a band of parchment paper on which a thick and sticky grease is placed. If properly done, the moth is unable to pass over the band, and is caught there. Each moth would lay from two to three hundred eggs, a large proportion of which would hatch out to the familiar green caterpillars that so frequently eat the trees bare in the spring and early summer. Where this grease banding is not done, the alternative is to allow the moths to lay their eggs. These hatch in due course, and the trees are then sprayed with a poisonous wash in the spring, so that in eating the leaves the caterpillars also partake of their share of the poison, which is usually arsenate of lead.

The necessity for dealing with pests either by the method of prevention or of cure is realised when one considers the amount of damage such pests can do to the food supply of the country, and it is no exaggeration to state that on an average, approximately one-tenth of every crop is lost annually through one or more diseases or pests. Frequently this percentage rises considerably, for example, when one gets a

"blight year" amongst the potatoes, and it is not unusual for farmers in such a year to lose at least half, if not more of their crop. What this means in figures can be calculated by considering the acreage of potatoes only in 1920. This is reported as 544,000 acres, and the crop should average out at 5,440,000 tons at the rate of 10 tons the acre. In all probability it will be somewhere approaching 3,264,000 tons, which is at the rate of 6 tons per acre, the average crop usually grown in England. Much of the loss is due to preventable causes.

In America, the land of big figures, the Codling Moth (the parent of the maggot in apples) is stated to cause an annual loss of nearly 2,500,000 tons, and the Cotton Boll Weevil costs Texas cotton-growers over £5,000,000 annually. A wilt [1] of tomatoes caused a loss of 50 per cent. of the crop in one State, while the loss in other States varied from 10,000 to 25,000 tons. Here future losses may be checked, as a wilt-proof tomato plant has been obtained. In the Laredo district of Texas a tiny "fly," known as a "Thrips," reduced the tonnage of onions which were exported by 20 per cent., and in Kansas in 1916 it was estimated that 250,000 acres of oats and 100,000 acres of wheat were destroyed by the "green bug." Even greater losses were sustained in Oklahoma, and it is added that "a good part of this infestation could have been prevented by a proper entomological procedure."

There is another side to the picture. The universities of California, as a result of work on a caterpillar pest of the peach, produced in one year an increase of 500 car loads of peaches, and from Holland comes the statement that as a result of the general use of grease-banding to control the winter moths, as mentioned above, £10,000 is put annually into the pockets of the Dutch fruit-growers. It is very difficult to get at the cost of checking pests, but a case from California is quoted where a severe attack of caterpillar was found on grapes. Here the system, which consisted of spraying the vines with arsenate of lead and nicotine, was applied for seventeen days, and the cost of materials, labour, and apparatus was £2,200. This was less than 4 per cent. of the net return, as the crop which was saved was estimated by the owner as being worth £60,000.

It is therefore obvious from such figures (and many more could be enumerated) that there is great scope for preventive measures in the growing of crops, although there is little hope of ever getting the full theoretical crop from any plant, because the cure of one disease frequently gives another disease or pest an opportunity of establishing itself. Still, by general hygienic methods many plants would be saved to provide food which otherwise would be wasted.

[1] The withering and death of a plant.

The word "Hygienic" connotes cleanliness, and townsmen, with visions of a farmyard and its frequently unsavoury contents, wonder where it comes in. In this connection, however, it means the general tidiness of fields and plantations, and the disposal of refuse therefrom. Quite a large proportion of the pests of the growers have to find a resting- or hiding-place from one season to another, or until the time when their particular fancy in the way of sustenance again grows on the field where they are. Their opportunity arises when the grower leaves the refuse of the crop lying about, whether it be on a farm, garden, or fruit plantation. On this the pest remains sometimes merely hiding, but more often in a resting stage, such as the pupa of an insect or the resting-spore of a fungus. Thus stubble will contain thousands of pupæ of tiny flies, which will ultimately be ready to attack a similar crop in the same field or one near-by. It is to obviate this that the farmers seldom follow a crop by a similar one in or near the same field (rotation of crops). It is, however, apparent that if the farmer could collect up and burn his stubble, he would burn up also its many thousand unwanted guests. In practice this is not deemed possible, and the usual alternative is to plough in and bury the stubble deeply so that flies cannot make their way out of the ground. This, however, is far from being effective. Fruit-growers for the same reasons should cut out the dead and dying wood from their trees and burn it promptly, for it is on this that many of their enemies breed. Thus one disease of plums, known, because it causes the leaves to become silvery, as "Silver Leaf," propagates itself only on dead wood. Consequently, the removal and burning of such wood is a hygienic method of protection, and this is now compulsory, plum-growers being required under a penalty to remove all dead wood each year before April 1.

Many diseases of plants, especially of root vegetables and potatoes, are caused by fungi,[1] which spend their resting-period in the soil. Here, again, the leaving of vegetables infected by such diseases to rot on the ground means the releasing of thousands, nay, in some cases, millions, of spores into the soil to await the arrival of a fresh crop in a succeeding year. And wait, they will, in some instances for ten years or more. Sometimes such vegetables as infected turnips, potatoes, etc., are fed raw to animals so that they shall not be wasted—only to get back to the land, and frequently to a clean field, with the manure, for the spores pass through the animals unchanged.

Numerous similar examples could be given, all

[1] A lowly group of plants, of which the moulds on moist bread, cheese, jam, etc., are examples, and which propagate themselves by minute bodies called spores, which act like seeds.

testifying to the value of prompt destruction of refuse, but these must suffice.

Mention, moreover, should be made of weeds. These are not only injurious directly by crowding out the proper plants and robbing the soil of food material,[1] but indirectly to a greater extent by acting as hosts for injurious pests and diseases which might otherwise starve before their normal food-plant was growing again in the field.

Growers are also by no means blameless as regards introducing a pest or disease to their crop. Thus fruit-growers buy trees that are infested with various pests which, by a little care and attention, could be got rid of at an early stage. Seed is sown which carries with it the spores of certain diseases, and plants like cabbages are bought which introduce diseases into hitherto clean soil. Of course the nurserymen or seedsmen are also to blame in such cases, and very shortly it will become an offence to sell plants or seed seriously affected with certain scheduled diseases. Many such diseases could be prevented by treatment at an early stage. Thus, cereals suffer frequently from a disease called smut, which causes the ears to produce sooty-like masses in the place of the grain. Suitable treatment of the seed by chemicals, such as formaline or blue vitriol (copper sulphate), will prevent this, and up-to-date farmers always "dress" their seed before sowing.

The prevention of disease by planting varieties which are immune from, or resistant to a disease, has been dealt with before,[2] and little more need be said. Although of partial application only, as the resistance is only to specific diseases, it can be used where a particular pest is rampant, and a crop obtained notwithstanding its presence.

"Dodging a pest" is also practical in some instances. Certain pests can work only within certain limits of temperature, moisture, etc., and if these are known, an attack may be prevented. Thus the early sowing of oats may prevent an attack of the frit fly, which causes much loss, and the late sowing of wheat in the autumn may save a field from attack by one of its parasites. Space prevents further illustrations, but one may conclude with a few words on prevention by preservation of a pest's parasites. The obvious case is the protection of insectivorous birds which feed on insects, the greater proportion of which are injurious. Besides these, there are smaller enemies of insect pests, such as the ladybird-beetles and their larvæ, or "niggers," as they are called; the larvæ of the lace-wing or "golden eye," and the larvæ of the hover-flies, which, as their name implies, hover over flowers; all of which feed voraciously on "green fly" or aphis. The hover-fly larva is a greasy-looking, elongated maggot with tiny head and no legs, and it has a very business-like way of picking up green fly, sucking them dry, and casting away the skin in a very short space of time. A few minutes' observation of one of these will show what effective aids they are to the grower. In America special attention is paid to the breeding of ladybird-beetles, some of which feed on scale insects and mealy bug as well as on aphis, and they are released where they will do the most good. Yet other insects, even smaller, are parasites, in or on the pests of plants, and these super-parasites, as they are called, help to keep in check many pests.

To sum up, growers of all kinds of plants are nowadays finding it much easier and cheaper to prevent pests by killing them in their early stages, when they are vulnerable, than to attempt to combat them by spraying when they have come to maturity and the damage has been done.

[1] DISCOVERY, February 1921.

[2] See article on "Immunity and Plant Diseases," DISCOVERY, June 1920, p. 197.

What is the Nature of the Unconscious Mind?

By Joan Corrie

AT this time, when the new psychology, or psycho-analysis, as it is generally called, is not only in actual use as a method of curing neurotic ailments, and a system of re-education for people who, from whatever cause, have failed to adapt themselves suitably to life; but also is made the subject of letters to newspapers, sermons from the pulpit, and discussions at afternoon tea, it may be of interest to try and examine in a simple and non-technical manner how the new psychology differs from the old, and what is the nature of the material with which it works.

Psycho-analysis differs from academic psychology in two very important particulars. First, it is *individual* instead of being merely collective. We used to learn how—all brains being made on the same pattern—all men think and feel and act. Psycho-analysis lifts the individual out of this generalisation and says to him, "Though specifically human in type, and so conforming to the laws which govern human thought, feeling, and action, yet because this one particular mind belongs to you, and not to A or B or C, therefore it is unlike all other minds, and is as individual and unique as your features, which yet as parts of a human face are possessed by everyone."

In the second place, academic psychology is almost

entirely concerned with conscious processes, whereas the new psychology is concerned with that infinitely larger part of the mind which is the subject of this paper, the *Unconscious*.

We may begin by asking, What is the unconscious? Quite simply, the answer is that it comprises everything that is not present to consciousness at any given moment. Round about the immediate objects of consciousness there is a semiconscious fringe which may at will become the focus of consciousness, so that on this level there is a shifting interchange between the conscious and the unconscious. For example, we will suppose I am engaged in balancing my weekly accounts. My conscious thought is concentrated on that, yet I am not entirely unaware of the room in which I sit, of some slight physical discomfort, of the fact that it is growing dark, and so on. If I choose, or even without my will, any part of this fringe can force itself into a more prominent position and displace my conscious focus. But below this lies an intangible barrier known as the " threshold," beneath which we come to the unconscious.

There is a well-known illustration by a noted author of the human psyche as an iceberg. Above the surface of the water a small portion—about an eighth—is visible, but the vast bulk lies below the waves. With this illustration in our minds let us attempt a short exploration, imagining a vertical shaft or passage through the iceberg. We have passed through the upper part representing the conscious mind, and we find ourselves below the threshold, or, in this case, the water. We are in the submerged part of the iceberg. What do we find there?

First, we find *Memories*. In the topmost layer, if I may so express it, we find our recent memories, the happenings or the thoughts of a day or a year ago. Most, probably, of these can be recalled with an effort, though many have sunk deeper and cannot be remembered. But as we penetrate further, we find that our whole life, as comprised in thought, word, deed, or event, has been preserved and is intact. A fraction of this mass can on occasion rise into consciousness, for the threshold is permeable and admits from below whatever is able to come up; but on the lower levels we find the forgotten past which does not and cannot rise, because it has been repressed from the conscious mind, either intentionally or in obedience to its own laws. This is the material which reappears in dreams and phantasies, usually in a disguised and symbolic form.

Secondly, we find *Phantasies* in the unconscious. These are chiefly concerned with desires which have no opportunity of being gratified in the conscious life, either because their nature is incompatible with the moral standard of the individual, or for lack of opportunity. These memories, phantasies, desires, do not lie in the unconscious like mud or débris at the bottom of a pool. On the contrary, they are living and active forces influencing the person's conscious life without his knowledge or will, and at times they can be animated by a terribly destructive energy causing neurosis, obsessions, and insanity itself.

This part of the unconscious is called by Dr. Jung, the leader of the Zurich school, the Personal Unconscious, because everything contained in it is to be found in the person's own life. Its chief characteristics are its infantility and its compensatory character.

The personal unconscious is infantile in nature in so far as it contains repressed materials, because our whole education is intended to make us " put away childish things," and we put them into our unconscious. The primitive, the child, and the unconscious think in the same way—by analogy. This is like That, therefore This is That, and is represented symbolically as such in the dream. Our childish passions, jealousies, wishes, outgrown in our conscious life, are to be found here. Above all our childish phantasies, our own private myths, are in the unconscious.

The second chief characteristic is compensation. Whatever value or lack of value is to be found in the conscious, its opposite is in the unconscious. Every individual possesses the germ at least of every human quality, but the aim of our civilisation has been to develop certain of these which we have elected to call " good," and repress others which we call " bad." Hence the compensation of the unconscious which tends to equilibration. Is a given individual a saint outwardly? If so, he has probably exaggerated certain qualities by the process of violently repressing others, which below the threshold maintain a life of their own disturbing to sainthood. Or has he given the rein to every desire and vicious impulse in his outward life? In that case, the lost values are below. In whatever direction the conscious life is one-sided, the unconscious tips the beam in the opposite one. Of course, the ideal is the mean in which conscious and unconscious act together in harmony, making one-sidedness impossible. It is not true that psycho-analysis, by bringing up from the unconscious material which, *while it is there*, is harmful to the individual, thus lets loose instincts and passions, to the great danger of the individual and of society. It is surely better that the saint, for example, should know by experience that he shares in the tendencies of the sinner, and, while controlling them, learn to live with them humbly, than that they should affect him from within unknown and unsuspected.

This short exploration of the personal unconscious by no means exhausts its nature, but we must hurry on into what lies around and beneath. We are now

at the lowest point of our submerged iceberg, and our next step takes us out of it into the fathomless ocean. This is Dr. Jung's Collective Unconscious. It is the Great Mother Unconscious of us all, into which we come at birth, and out of which we slowly and painfully differentiate our own individuality. We find in it our family characteristics, then our ancestral and racial peculiarities, and finally the qualities of primitive man and of his forebears the animals. All instincts, human and even pre-human, are here, all the fundamental thoughts and ideas peculiar to man from the very constitution of his mind, all the gods and all the devils, all that has been in the past, and all the possibilities of the future for the individual, and for the race through individuals. Everything is here in the collective unconscious, and when the barriers are down, anything is possible, anything may rush in to the conscious mind, to the immense enrichment of the individual's life, or—if he has not learned to navigate this illimitable ocean—to his absolute undoing.

In closing, one last characteristic must just be alluded to. The unconscious is the great generator and reservoir of psychic energy. The principle of the conservation of psychic energy seems to hold like that of the conservation of energy in the physical world. Each person has a stock of energy which is constantly transformed, but never diminished or increased. It is always actively creative, and beneficent or injurious according to the use to which it is put. As long as it is in contact with Reality, whether objective or subjective, it is constructive. But turned back upon itself, and only engaged in creating the phantastic and unreal, it destroys, for it then begets neurosis, disease, insanity, and even death itself.

BOOKS FOR FURTHER READING

Collected Papers on the Psychology of Phantasy, by Dr. Constance E. Long. (Baillière, Tindall & Cox, 10*s*. 6*d*.)

Analytical Psychology, 2nd Edition, by C. G. Jung, M.D., LL.D. Edited by Dr. Constance E. Long. (Baillière, 18*s*.)

Psychology of the Unconscious, by Dr. C. G. Jung. (Kegan Paul, 25*s*.)

Dream Psychology, by Dr. Maurice Nicoll. (Oxford University Press, 6*s*.)

The Interpretation of Dreams, 7th Edition, by Dr. Sigmund Freud. Translated by Dr. A. A. Brill. (Allen & Unwin, 15*s*.)

Reviews of Books

Government and People. An Introduction to the Study of Citizenship. By CONRAD GILL, Reader in Constitutional History in the University of Birmingham, with the collaboration of Professor C. W. VALENTINE. (Methuen, 7*s*. 6*d*.)

What proportion of the adult population of this country could say off-hand when a parliamentary session normally begins and ends, what the common law is, what a district council does or may do, what is the significance of votes of supply, appropriation bills, and grants in aid, how long the police system has been at work, or how the Consolidated Fund is managed ?

This sort of knowledge, and much more, ought to be part of the stock-in-trade of everyone who claims the rights of citizenship. But at the present time most people have only a shadowy idea of the way in which public business is carried on : consequently they are at the mercy of the few—journalists, officials, politicians, financiers—who have taken the trouble to learn something about government. Even these few are often more interested in party wire-pulling than in studying the public welfare. If only a moderate proportion of the voters had a fairly clear idea of the way in which they were governed, political progress—carrying with it a good deal of social progress as well—would be incredibly swifter than it is. Above all, if we knew the *possibilities* of government—the unused powers of promoting public health, education, town-planning, agricultural development, and the like—they would be so stirred with the vision of England as it might be, that they would never rest until the vision had become a reality.

Some of these possibilities are suggested in the chapter of *Government and People*, which deals with " The Aims of Government." It is shown that the three great aims are security, justice, and liberty, and that in all these lines the sound policy is continually to screw up the minimum standards—whether of material welfare, knowledge, or conduct, the final aim being the opportunity of a full life for the whole people.

But the authors are careful not to lay too much stress, or to repose too much hope, on the work of government. They argue that the impulse of progress must generally be sought among the people rather than the rulers ; and, in common with many modern thinkers, they look upon the State as only one of many organisations that keep society together, and help it forward—or backward as the case may be. The main reason is given on p. 279:

" Nearly all changes are due to new ideas, whether in art, religion, philosophy, science, poetry, politics, trade, agriculture, or any other line of activity. Now it sometimes happens that a leading statesman is distinguished in some other line than statesmanship. He may be a great churchman, like St. Bernard, Louis IX, Luther, Calvin, and Knox ; a poet, like Dante ; a scientist, like Bacon ; a scholar, like President Wilson, Mr. Fisher, Lord Morley, and Lord Bryce ; a philosopher, like Mr. Balfour ; an agriculturist, like Lord Townsend and George III ; a musician, like M. Paderewski. He may be eminent enough in his own sphere of work, as Bacon was, for example, to contribute ideas of profound importance for the future of mankind. Such cases, however, are rare exceptions. Most rulers are specialists in politics, and they have little time or energy to devote to other callings. Therefore almost all new ideas come from men who are not busily engaged in the work of government. The proper concern of government is not so much to create progress as to provide those

conditions of peace, security, and freedom in which progress can best take place."

The authors go on to compare Government and people to a shepherd and his flock, with the Executive as the sheep-dog. "Present-day opinion," they say, "regards sheep, shepherd, and dog as having very nearly the same level of intelligence, and as engaging in an agreeable co-operation in the search for new pastures. But it is the sheep themselves who do most of the discovery, while the special task of the shepherd and his dog is to keep order, to take care of the lambs, and to help the sheep that have grown old or infirm. . . . A cynic would perhaps be inclined to add that at the present time the shepherd is actively engaged in fleecing the flock."

Let us hope that a new and golden fleece may grow before long.

Territory in Bird Life. By H. Eliot Howard. (John Murray, 21s.)

Mr. Howard deserves our gratitude, for he has brought to light a new factor in the life of birds. His conception of "territory" and the part it plays in the avian life-cycle was already outlined in his remarkable monograph on the British Warblers. That, however, was costly and not readily accessible; and we are glad that he has devoted a separate work to a consideration of the idea and of its general bearings.

It is refreshing to find field-work leading to conclusions of such wide application. The average ornithologist had begun to think that there was nothing new to be learned from British ornithology at least—nothing but an amplification of our old knowledge. In reality, the most valuable results lie waiting for those who have the interest and the patience. The reviewer remembers with what surprise he discovered that the courtship habits of such a common species as the Redshank were scarcely known, and the wonderful pleasure that it was to dig up new facts and new general ideas from the nuptial activities of the Crested Grebe.

The man who is content to make records or to collect skins and eggs will, unless he spend years of his life in a systematic analysis of his own and others' facts, not get anything from his labours—save the very real pleasure of making the observations. But he who takes the trouble to think out new problems and new lines of attack upon the old will have the same pleasure, and in addition the joy of intellectual discovery. It is the man who is willing to build an observation post in a rookery, to make a detailed psychological study of any common bird, to observe the whole sexual cycle of a species—always with some general idea to guide him—who is likely to achieve results.

As the field studies of Bates introduced us to a new idea—of Mimicry in butterflies—so do these of Howard to a new idea—of Territory. As a result of seasons of patient watching among English fields and woods, he has arrived at the conclusion that practically all our birds, when the mating season comes round, stake out a territory for themselves, and that this territory is in most instances the pivot on which their sexual life turns. Usually it is the male who annexes the territory, spending all or most of his time in a given, limited area which he defends from other males; and this annexation occurs long before he appears to manifest any interest whatever in the females. We find that this occupation of territory takes place in essentially the same way in migratory and non-migratory forms, and in forms belonging to the most widely different groups. In the Warblers, the males come over from their winter-quarters a week or more before the females. They then occupy a definite area, fighting, if need be, for its possession, and spend almost the whole of their time in singing. When the females arrive, there is no courtship in the ordinary sense; on the contrary, the males seem to be almost oblivious of their future mates, and any fighting there may be is between females, for the possession of the occupied territory! Only after the territory is thus staked out, and occupied by a pair of birds, do the activities which are usually summed up as "courtship"—a very poor term in this case—begin, the male assuming the most extravagant attitudes and performing actions obviously directed at the female.

In non-migratory passerine birds like the unrelated Fringillidæ, the same sort of procedure is gone through. Yellow Buntings, for instance, during the winter collect in flocks on the stubbles. As spring begins, male birds will detach themselves from the flock for a short period each day, and repair to a particular stretch of hedgerow, in which they will spend most of their time on a particular tree, singing. As the season advances, they will spend less and less time with the flock, more and more in the territory, in ever greater activity of singing—until at length the flock has disappeared, since the females finally leave it too, and search for a mate and a home, as in the Warblers.

Even in quite a different order of birds the behaviour is similar. Peewits have their territories round the nest, staked out in just the same way by the males in early spring, some time before any sexual activity proper is in evidence at all.

In fact, Mr. Howard claims that territory in some form or other plays a part in the life of all birds, and substantiates his claim for the most unlikely forms—promiscuously-mating species like the Cuckoo, gregarious cliff-dwellers like the Guillemot, and even (though here, it must be confessed, with considerable limitations) polygamists like the Blackcock or Ruff. Not only does he make this claim, but I think it must be allowed that he substantiates it.

Territory is most important of all in forms, like the Warblers, where the young are hatched naked, and cannot be left long uncovered without risk of dangerous chilling. Here the size of the territory is regulated according to the food-supply and the ability of the parents to find it, and the pair spend the whole of the breeding-season within its confines. A similar state of affairs holds for Kingfishers, which divide up their rivers into sections. The Crested Grebes, on the other hand,

make the open water a common fishing-ground, and only delimit territories round their nests in the fringing beds of reeds. Finally, in such birds as the Guillemots and other cliff-dwellers, whose nesting space is exceedingly limited, but whose feeding-ground is the unbounded sea, the territory is restricted to a few square feet upon a ledge of rock. It is none the less important for that, and the same instincts are displayed to stake out claims, the same fights occur for possession.

During the breeding-season, the whole instinctive life of the bird is conditioned by the territory first and foremost, and only in lesser degree by the presence of its actual or potential mate. Of this curious fact, which holds most rigorously in the common monogamous birds, Mr. Howard gives a number of instances. For example, he observed how the male Lapwings which had detached themselves temporarily from the flock, and were occupying territory, were quarrelsome and impatient of intruders, whether male or female, while the same birds during a part of the day when they had returned to the flock were as good-natured as the rest. But if the flock happened to be frightened up into the region of the territories, their occupiers would be just as jealous of the presence of the flock as of single birds. Further, in this stage of the yearly cycle the males took no particular interest in the females.

It is impossible to go into more detail here. The theory of Mr. Howard in most general terms may be stated as follows. Territory in some form or other is of prime biological importance in the life of birds (and probably of other groups as well). The first sign of sexual activity—the first effect, presumably, of the vernal change in the sexual organs—is in most species seen in the instinct of the males, not, as has usually been assumed, to seek out the females, but to find, occupy, and defend a territory. So far as there is choice of mates in monogamous species, it is by the females, who seek out the males; but they only compete for those males who are in possession of territory. Even when the pair is established in the area, the occasions when the female is the primary object of the male's actions is only during the so-called courtship, whose function is to stimulate the female psychically and bring her to the condition in which pairing may be accomplished; but both male and female, singly and as a pair, still react to the fact of territory, and are always active in its defence. Mr. Howard quotes an illuminating observation: he saw a weasel passing through the territory of a pair of Reed-Buntings, who were pursuing it in rage. Another male of the same species of bird approached. But instead of welcoming it as an aid in driving off the intruder, the male whose nest was actually in danger several times left the pursuit of the weasel to attack the other Reed-Bunting!

It is clear that such a concept is of great importance, both as something new in itself, and as exerting a marked influence upon our theories of sexual selection. The primary sexual instinct of birds becomes the instinct to occupy territory; the primary function of song is to advertise the possession of territory.

We congratulate Mr. Howard upon having discovered a principle of such importance, upon the intrinsic interest of the observations on which he bases his case, and upon the presentation of that case in this work. Praise is also due to the charming illustrations by Lodge and especially by Gronvold—full of life and point.

Here and there Mr. Howard has perhaps generalised a little too far. The mental life of birds is more varied than most people think, and their life-histories show most remarkable divergencies. Mr. Howard has for the most part confined himself to Passeres and to Limicolæ. In other groups, things sometimes are a little different. For instance, in the Crested Grebe, hostility between pairs does not seem to be manifested only within the boundaries of the territory of one of the pairs, but anywhere. This would mean that the mate played a more important part in conditioning the mental reactions than in Warblers or Buntings. Again, in Herons and Egrets (at least in the two American species with whose habits the reviewer is familiar), it is not the male who seeks out the territory long before pairing-up, but pairing-up occurs on the communal feeding-grounds, and the couple then, deserting the flock, *together* choose and occupy a nesting-site (often abandoning one or two sites before finally satisfying themselves). Mr. Howard also believes that one bird of a pair which is in possession of territory will never desert its mate in favour of another bird. However, the female of a pair of Black Swans which recently came under observation not only deserted its mate for an older bird, but now takes an active part in driving its former husband off whenever he appears upon the scene.

These, however, are minor points. The main thesis stands, and will remain of prime importance for our understanding of the life of birds. The general biologist no less than the naturalist and the lover of birds should read and ponder this book.

JULIAN S. HUXLEY.

The Essentials of Mental Measurement. By WM. BROWN, M.D., D.Sc., and GODFREY H. THOMSON, D.Sc., Ph.D. (Cambridge University Press, 21s.)

This is a new volume of the Cambridge Psychological Library. It is a revised and expanded edition of Dr. Brown's book published in 1911. A large amount of new material has been added by Dr. Godfrey Thomson. For experts and students only.

Queen Victoria. By LYTTON STRACHEY. (Chatto & Windus, 15s.)

The Mystery of Space. By ROBERT T. BROWNE. (Kegan Paul, 15s.)

The Great Riddle. By FRANK HORRIDGE. (Kegan Paul, 3s. 6d.)